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# SURGERY OF CHILDHOOD

CLINICAL PEDIATRICS

# SURGERY OF CHILDHOOD

BY

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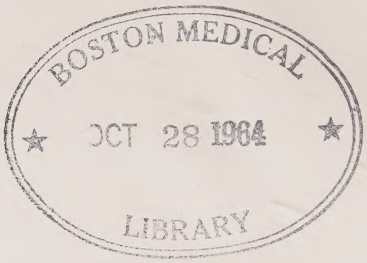


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# PREFACE

This book has been written with a strong conviction of the necessity for effective coöperation between the general practitioner and the pediatric surgeon. Surgical results in children are largely determined by the general practitioner in his prompt recognition of the surgical condition, in his adequate appreciation of the necessity for appropriate treatment at the most favorable time, and in his judicious control both before and after operation, of the factors of nutrition and care. Special attention has therefore been directed to diagnosis, indications for operation, choice of time for operation, probable results and preoperative and postoperative care.

I have tried to cover the field of pediatric surgery, *excluding the problems pertaining to orthopedics*. I have stressed conditions peculiar to infancy. This has been done in the belief that wider familiarity with such conditions will bring about their earlier and more frequent recognition.

Richard W. Bolling.

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# PUBLISHERS' ANNOUNCEMENT

The publishers take pleasure in presenting to the medical profession the series of monographs of which this volume forms a unit.

The many inquiries which reached them proved, in advance of publication, that the work should be in monographic form and clinical in its presentation.

The series when completed will, they believe, be the most useful for the audience for whom it is written, the general practitioner of medicine, that has been presented in its particular field.

The authors are all men of wide experience and, in the main, teachers. The combination makes the work authoritative and of the utmost service in a field which has been often termed a "therapeutic specialty."

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# SURGERY OF CHILDHOOD

## CHAPTER I

### GENERAL CONSIDERATIONS

Early life may be divided into two periods, infancy, comprising the first two years, and childhood, through the third year to the development of puberty. Surgical disease in young children often does not manifest itself as in the adult, and the practitioner must appreciate this difference and be able to interpret it correctly. He must have a clear understanding of the various congenital conditions and know the usual surgical diseases which occur at the several periods of infancy and childhood. He must realize that, not only are certain diseases peculiar to certain periods of growth, but that a given disease may vary its manifestations as it is observed at different stages of the child's physical development. The contrast to adult life is greatest in infancy and becomes progressively less until, after puberty, the child becomes the adult.

The accuracy in diagnosis, so essential to successful treatment, is peculiarly difficult of achievement in infancy and early childhood. At this period the cellular changes are more active than in the adult, there are greater nutritional demands and the organism is less stable. The activity of growth renders children liable to a violent reaction from slight cause and makes disease sudden in onset and intense in its symptoms. There is a more general reaction to disease or injury and there is not the same tendency to a limitation of symptoms to a particular organ or region, as in older children or adults. The younger the child the more striking it is that the expression of disease is more constitutional than focal. Digestive symptoms accompany most of the diseases of infancy and on careful analysis the "upset stomach" is often found to be a part of some acute infection. The response to stimuli varies at different periods of growth. For instance, the very young infant is comparatively free from convulsive seizures, and a convulsion in the first two months of life is almost always due to gross injury or infection in the central nervous system and is of serious import. On the contrary, after the second or third month, and until the end of infancy, all of the nerve-centers are most irritable, and convulsive seizures are common. The onset of any acute infection at this period may be accompanied by a convulsion which may be of relatively little significance. These dif-

ferences must be carefully considered in determining the import of symptoms. However, disease in the child is usually uncomplicated and the various degenerative diseases, so frequent in adult life, are conspicuous by their absence.

The activity of growth has a definite bearing on prognosis as pointed out by Holt. In the young, under favorable conditions, we may count not only on the normal process of repair but also on the additional vital factor of growth. The extent to which, in infants and young children, growth may aid in the repair of certain lesions of organic injury and disease, must receive careful consideration by the surgeon. For instance, the capacity for restitution of form in malunion after fracture at this period is remarkable. In infants a postoperative ventral hernia, if carefully retained by strapping or belt, not infrequently disappears in the process of growth. Due consideration must be given to these facts before operation is undertaken in such cases. In certain children, particularly those who suffer from chronic intestinal indigestion, the Roentgen ray may reveal surprising redundancy and dilatation of the colon, particularly the sigmoid. The condition may be so extreme as to suggest so-called congenital idiopathic dilatation of the colon or Hirschsprung's disease. Under proper treatment and in the process of growth, restoration to normal relations may be complete. Recourse to radical surgery would not be considered by one familiar with the natural history of such conditions.

There is a place in every community for the surgeon who, in addition to his general training in surgery, extends his knowledge to the particular problems which arise in the surgery of children. The surgeon, however skillful he may be in any branch of adult surgery, who occasionally operates on an infant or young child, cannot expect to get the same results as the man of equal skill who has familiarized himself with the peculiarities of disease as manifested in young children and who operates regularly on such patients.

Infants make excellent subjects for properly planned and skillfully executed operations. They do not, however, stand well the loss of blood and they are sensitive to trauma and exposure. The careless, rough surgery, which in adults results in a stormy convalescence, may often contribute to the death of an infant.

On the other hand, the most skillful surgery cannot do much to overcome the consequences of delayed diagnosis. The child with a ruptured appendix and spreading peritonitis, in the hands of a master, does not stand as good a chance of recovery as the one who, receiving far less skilled surgical care, has an inflamed appendix which is not yet ruptured.

There is furthermore, in children, an especially close relation between the general condition and the state of nutrition and the outcome of a

surgical procedure. The disease, or injury, can even less than in the adult, be looked upon simply as a field for operative endeavor. An empyema in an infant implies not only a surgical operation and repeated dressings, but an infinitely complicated problem in feeding and medical management generally.

The surgeon's dependence upon the practitioner is obvious and it is impossible to overemphasize the need for well organized teamwork on the part of both.

## CLINICAL EXAMINATION

**History.**—The clinical examination of young children is a matter full of difficulty to the inexperienced as it has to be carried out not only without the help of the patient, but often in spite of his opposition. In an emergency of injury or disease special examination of the affected parts may be proceeded with at once, reserving until later a systematic survey of the history and a complete physical examination. In most cases, however, it is better to proceed methodically and first elicit the history. It is especially desirable in the case of a child that a careful history be heard first so that the examination be rightly directed and an injured or painful part not unexpectedly encountered. In the case of children under eight or ten years the history is usually best obtained from the mother or nurse. The account must be carefully considered with due reference to the narrator's intelligence. Parents or guardians often make misstatements, either unintentionally through ignorance, or intentionally when by doing so they may hide their own carelessness or negligence. Others will knowingly exaggerate all of the symptoms, either to excite greater interest or from some morbid tendency. Intelligent and tactful questioning minimizes such inaccuracies. It is usually wise to let the person who is giving the history tell it in her own way and clear up the uncertainties or elicit new facts by subsequent questioning. Observations made by one well acquainted with the child are often of value and reveal conditions which might otherwise escape the notice of one who sees the child for the first time. No statement, however improbable, can be entirely discredited without sufficient reason.

The systematic method of obtaining histories has been adequately described elsewhere, but certain points may be emphasized. The history is, at times, of even more importance than the physical examination. This may be true for instance in the case of acute intestinal intussusception. The date of onset of the present illness should be fixed as accurately as possible. Misstatements are particularly apt to occur upon this point and when there is uncertainty it is best to date the onset from the last period at which the child was known to be perfectly well. The duration of the disease may have considerable weight in determining not only prognosis but in some

instances the advisability of emergency treatment. Acute intestinal intussusception with a duration of ten hours has, in general, a very different prognosis from a similar condition which has lasted four days. The urgency of intervention in an acute abdominal condition, possibly an acute appendicitis, with a duration of twelve hours, differs from that in a similar condition which has lasted five days. Careful inquiry must be made in regard to the relation of trauma to the onset of symptoms. Not once, but many times, has fracture of the femur in an infant been mistaken for an acute epiphysitis or scurvy. When there is a history of pain, its character and location and whether it is constant or intermittent are important. The recurring attacks of abdominal pain with a definite free interval are quite characteristic of acute intussusception. If there has been vomiting, not only the type of vomiting, projectile or not, but the frequency and length of time between attacks and the character of the vomitus are important. The character of the stools when blood has been passed, whether the blood is mixed with the feces or the stool consists entirely of blood and mucus, should be noted. When there has been abdominal distention, the duration, whether the condition is intermittent or progressively increasing, and the appearance of peristaltic waves, are all matters of value.

While the history is being elicited opportunity may be taken to establish friendly relations with the child. During this period also opportunity is afforded for inspection and much information may be obtained in this way. Certain diseases are associated with characteristic facial appearances. At times careful inspection may afford fully as much information as the most careful physical examination. For instance, in a case of beginning pneumonia, with indefinite physical signs in the chest and abdominal symptoms, the general appearance is of great value in arriving at a diagnosis. The position assumed by the sick child may be suggestive, as the dorsal position with knees drawn up in peritonitis, or the lateral position in empyema.

**Physical Examination.**—The physical examination is next proceeded with and there should be a well directed plan, but not always may the steps of the examination be made in the order planned. It is almost impossible to examine satisfactorily a crying, rebellious child. The physician is, to a certain extent, dependent on his predecessors and if the child has an unpleasant memory of doctors, the way to his confidence is doubly hard. Undoubtedly certain people are better qualified than others to get on with children, but granted a physician with ample time and the wish to make friends, he will almost always succeed. It is easier to do this if the patient is at home than if he is brought to the office. Fraser calls attention to two types frequently met with. The precocious child who likes to be taken notice of and spoken to and the diffident, shy individual who is alarmed by what he considers unjustified advances. With the former one may strike

up an immediate acquaintance. The latter it is better to ignore at first until possibly he is piqued by neglect and more open to advances. With infants, of course, the problem is different and the most satisfactory examination is made with the child asleep or in his mother's arms. The infant's usual feeding or a sugar pacifier is often a help.

The methods are identical with those employed in adults but the examiner must be prepared to vary his program instantly according to the behavior of his patient. The examination requires, above all, gentleness and deliberation combined with infinite patience and good temper. For instance, with the finger well lubricated, and by very gradual insertion, the rectum can often be examined without any resentment. Nothing is to be gained and everything lost by haste or abruptness. One has to seize the opportunity of ascertaining a fact as it presents itself, and the disagreeable procedures should be reserved for the last. The examination should be conducted in a comfortably warmed room and the patient should be stripped.

If during the examination the child can be drawn into a conversation, or better still, his mind diverted by a running stream of not too consequential talk, the procedure will be made easier. In young children giving them some toy or bright object to play with and in infants feeding may serve a similar purpose. In certain instances of bad training where the child is "spoiled," there is little chance of securing coöperation and he must be dealt with firmly and forcibly.

The first step in examination is the estimation of the patient's general condition and development, the appearance of the skin and mucous membranes, the quality of the circulation and particularly whether there is evidence of dehydration, manifested by loss of elasticity in the skin. The condition of the mouth in children who have been ill for some time is an index to the type of care received. The characteristic acetone odor to the breath is certainly important if observed but it is rarely actually present. The respirations which vary normally from 40 in the newborn infant to 25 at the fifth year may be counted by merely watching the movements of the abdomen. The pulse rate at birth is about 130, by the second year it is 110 and by the eighth 90. In infancy the examination of the pulse is of comparatively little value. The quality is difficult to ascertain and irregularity is of little significance. However, if the pulse be slow as well as irregular, it is a serious sign.

Following this there is a local examination of the part affected. This is always preceded by examining, if possible, the corresponding sound region that the child may not be frightened by the pain of first contact. It is not wise to deceive a child as to the painfulness of any procedure and

it is often surprising how stoical a small child may prove to be if care is taken to explain beforehand what is going to happen.

In examining the abdomen the same routine is followed as in an adult. Inspection may reveal irregularity in contour, dilatation of the superficial veins, pouting of the umbilicus, or visible peristalsis. For palpation it is particularly important that the hand be well warmed. In the case of younger children, unless the illness is extreme, it is unlikely that the patient will lie quietly on his back throughout an extended examination. A very satisfactory examination may often be carried out with the child in his mother's arms, on his hands and knees or even while he is crawling about the bed. Palpation reveals the degree of distention, the presence or absence of tenderness and muscular rigidity, fluctuation, the presence of abnormal masses and enlargement of organs. Percussion sometimes aids in determining the nature of an enlargement. Where abdominal examination is unsatisfactory, anesthesia is often indicated. The value of an abdominal examination is greatly enhanced by a bimanual examination, one finger in the rectum and the other hand on the abdomen.

The examination of the chest has been fully described elsewhere. The mouth, throat and ears must be carefully examined in every instance and in infants the condition of the fontanel noted. Infection localized in the middle ear, the mastoid or the accessory sinuses of the nose may result in symptoms apparently referable to the gastro-intestinal tract, the heart, lungs, kidneys or other organs. Palpation of the pharynx should not be a part of any routine examination and should only be practiced when there is a definite indication. The extremities are investigated and particular attention is given to the joints and regions of the epiphyses. At the completion of the examination the rectal temperature is taken. A urinalysis and blood-count form a part of each examination. The importance of urinalysis in infants must not be overlooked as acute pyelonephritis may give signs of peritoneal irritation suggesting appendicitis or diverticulitis.

The use of the Roentgen ray is of the greatest value in children. The examination can be carried out at any age and often determines the diagnosis. An opaque meal or enema may be given in the earliest infancy and the former is indicated without delay in persistent vomiting in the first few days of life when the diagnosis is not definite. In infants and unruly older children it may be necessary to administer the opaque meal through a catheter or stomach-tube. When the mixture is too thick to run from a funnel through the tube, a syringe is attached. When the infant will nurse, the meal may be given from a bottle after the hole in the nipple has been somewhat enlarged. The ordinary formula may be used with the addition of bismuth subcarbonate in the proportion of one part to eight of formula. The quantity is that of an ordinary feeding for a child of

the same age. If the barium sulphate mixture is used it should be diluted with one or two volumes of water or milk. In children over two years a mixed feeding may be given. In involvement of the lung or pleura systematic use of the Roentgen ray is of great value. A roentgenogram of the chest often aids in clearing up the diagnosis in beginning pneumonia where the abdominal symptoms are such as to suggest appendicitis.

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## CHAPTER II

## WOUNDS OF THE SOFT PARTS

Bruises and minor wounds are frequent. They usually heal well and require little care after the first dressing. The application of half strength tincture of iodin or 2 per cent mercurochrome followed by a sterile dressing is usually all that is necessary. The application of mercurochrome causes less discomfort than does tincture of iodin and for that reason is preferable. There is sometimes difficulty in choosing a suitable dressing. Scalp wounds and wounds of the extremities are best dressed with gauze and bandage. On the face a collodion dressing or gauze and adhesive plaster are most easily applied; wounds on the body are dressed with gauze and adhesive plaster, and wounds about the lips should not be dressed but should be covered with a film of boric ointment.

Wounds of greater extent, if seen within the first twenty-four hours, should be sutured. Incised wounds, if not obviously contaminated, may be sutured at once after the application of iodin or mercurochrome. Lacerated and all obviously contaminated wounds should be carefully prepared before closure with suture. This preparation consists in as careful complete excision of the tract of the wound as its anatomical situation makes possible. This procedure is based on the fact that for some hours after injury the infection is limited to the superficial portions of the wound. It is of course essential that all devitalized tissue be removed and the recognition of this tissue is aided by staining the wound with 1 per cent aqueous methylene-blue, the dead tissue being more deeply stained. Equally important is careful control of all hemorrhage.

**Tendons.**—Wounds of tendons should be repaired as soon as possible. A primary tendon suture has a much better outlook than a secondary repair.

**Late Wounds.**—Wounds seen after twenty-four hours and all wounds grossly contaminated with soil should be cleansed, the surface excised if the wound is recent and lightly packed with gauze wet with half strength tincture of iodin. In extensive wounds in which primary suture is not possible, intermittent irrigation with Dakin's solution after the method of Carrel is of great value. When properly carried out this method results in rapid sterilization of the wound with little discomfort to the patient. Large wounds treated in this manner may be sutured secondarily, the time for the suture being determined by the results of cultures and smears from the wound surface.

## TETANUS

Tetanus is a disease resulting from infection of a wound by a specific microörganism, the tetanus bacillus. The pathogenicity of this organism depends entirely upon the soluble toxin which it produces in the wound of infection. This toxin has a special affinity for the cells of the central nervous system and travels from the focus of infection by way of the fibers of the motor nerves. The comparative infrequency of the disease is in marked contrast to the wide distribution of the bacilli in nature. The organism does not readily establish itself in the human body. The nature of the wound and the presence of other organisms seem to be important factors in determining whether the bacillus shall be able to proliferate. Lacerated wounds in which there has been much tissue destruction and in which foreign bodies are present, favor multiplication of the organism. Wounds contaminated with barnyard and garden soil are particularly dangerous. It must be remembered, however, that the disease may develop following a slight, even superficial wound, and this seems particularly true in the case of children.

This disease is characterized by increased reflex excitability, hypertonus and spasm of one or more groups of voluntary muscles. There are several clinical varieties in which the difference is mainly that of degree.

**Acute Tetanus.**—This type is characterized by the shortness of the incubation period, the severity of the symptoms and the rapid progress of the disease. The disease may manifest itself within three or four days of the infection of the wound; most frequently, however, seven days elapse. The incubation period may extend itself to three weeks, in which case the condition is known as delayed tetanus. In this event the wound may be entirely healed. If an accurate history is obtainable, there will usually be found some prodromal symptoms. There may be a slight elevation of temperature, the wound region may become painful and tender and the muscles in its immediate vicinity be contracted. Often, however, the first complaint is of headache and general depression followed by stiffness in the muscles of mastication, notably the masseter, and difficulty in opening the mouth. Gradually there develops a spasm of the muscles of the cheeks which results in a retraction of the angles of the mouth—the characteristic "risus sardonicus." The muscles of the neck, particularly the sternomastoid and the trapezius, are next affected. The diaphragm and the muscles of the anterior abdominal wall become contracted. Later the muscles of the back and chest and lastly those of the limbs are affected. While this is the usual order there are wide variations. To the tonic contractions, clonic spasms are soon added. These are at first slight and separated by prolonged intervals, but rapidly become more frequent, severe

and of longer duration. The slightest external stimulus, even a sudden draft of air, will determine an attack.

In chronic tetanus the period of incubation is longer, the onset is insidious and the progress is slow. The duration is from six to ten weeks and every day the patient lives adds to his chance of recovery.

Local tetanus is the term applied when the muscular involvement is localized to the region of the wound. That tetanus may manifest itself in involvement of a single limb is not generally known and the disease in this form may be easily overlooked. Attention is usually directed to the condition by the pain accompanying the spasm.

Tetanus neonatorum is the form occurring in newly born infants and is due to infection of the umbilicus and manifests itself usually before the tenth day. This form of the disease is fatal in at least 90 per cent of the cases but fortunately is very rare nowadays, due chiefly to the importance which is attached to the careful treatment of the umbilical cord. In addition to those referred to, there are many types of atypical tetanus.

*Differential Diagnosis.*—There is usually little difficulty in diagnosis in a case of acute tetanus but there are certain other conditions with which it may be confused. In strychnin poisoning there is a history of administration of the drug and the muscles are relaxed between the convulsions. In hydrophobia there is a history of dog bite and the spasms, which affect chiefly the muscles of respiration and deglutition, pass off entirely between the attacks. Meningitis may present a certain superficial resemblance to tetanus. Tetany is distinguished by the age at which it usually occurs and by the jerking character of the spasms which affect chiefly the hands and fingers.

*Prophylaxis.*—Efficient care of the wound as soon as possible after its receipt is the most important feature in prophylaxis. This comprises mechanical cleansing with removal of foreign bodies, excision of wound edges when necessary and disinfection with half strength tincture of iodin.

It has been established that the routine administration of antitetanic serum to patients with lacerated and contaminated wounds greatly reduces the frequency of tetanus. Therefore, its use is indicated in all lacerated and punctured wounds, particularly in blank cartridge wounds and where there has been contamination with barnyard, garden soil or street dirt. The serum should be given as soon as possible after the injury and the dose should be from 500 to 1,500 units, administered intramuscularly and preferably in the vicinity of the wound. As the antitoxin gradually disappears in the course of about twelve days, a second injection, with due precautions to prevent anaphylaxis, may be called for in the case of wounds which are slow in healing or in which some secondary procedure becomes necessary.

When tetanus has developed the chief indications are to prevent the further production of toxin in the wound and to neutralize that which has been absorbed. Thorough cleansing of the wound, excision of devitalized tissue and free drainage should be promptly carried out. In as much as this might conceivably increase the activity of the organisms for a time the treatment of the wound is delayed until after the administration of the first dose of serum, which should be carried out at the earliest possible moment. To neutralize the toxin already absorbed, from 3,000 to 10,000 units of antitetanic serum should be injected intrathecally. Before injection an amount of spinal fluid corresponding to the amount of serum to be injected should be withdrawn. These doses may be repeated at intervals as indicated by the symptoms, but if the serum is administered promptly and in sufficient amount a second dose may be unnecessary. In addition 10,000 to 20,000 units of serum are injected intravenously. It is claimed by some that the risk of anaphylactic shock attending intravenous injection outweighs any benefit, and the intramuscular route is preferred. Enough spinal depressants, preferably chloral and bromids, to produce a physiologic effect are administered. In addition careful nursing and the maintenance of nutrition by the administration of an adequate amount of fluid and nourishment are important. Where the diagnosis of tetanus is suspected, treatment with serum in adequate dosage should be instituted at once. A delay of even a few hours may determine a fatal result.

In the case of tetanus neonatorum the administration of a 10 per cent solution of magnesium sulphate subcutaneously in amounts of 0.2 gram of the salt to each kilogram of body weight has been advised for the symptomatic effect in that normal feeding is made possible.

## RABIES

(*Hydrophobia*)

Rabies is an acute, specific, infectious disease of the central nervous system, occurring commonly in mammals and communicated to man by the bite of a rabid animal (usually a dog). The disease is characterized by a variably long incubation, by a short course and by the fact that death is practically certain after symptoms have once developed. Rabies is fairly prevalent in almost every civilized country with the notable exceptions of England, Australia and Norway. These countries are practically free from the disease because of strict laws relating to the importation and muzzling of dogs.

All persons bitten by rabid dogs do not develop hydrophobia. Probably different strains of the virus of rabies differ in infectivity. The nearer the

bites are to the brain the more certain is the infection. Bites upon exposed parts are more dangerous than those in which the virus may be removed by the passage of the teeth through the clothing. The disease may be transmitted by saliva on an abraded surface. Nearly half the cases occur in persons under twenty. It has been shown that about 35 per cent of persons bitten by rabid dogs will, if untreated, develop hydrophobia and die. It is important to remember that the saliva of a dog may be infective for as long as fifteen days before symptoms of rabies are evident.

**Clinical Features.**—The period of incubation in the human infected with the virus of a rabid animal varies generally from about forty to sixty days. It is rarely earlier than twelve nor later than ninety days. The victim at first complains of lassitude, malaise, and the temperature may be slightly elevated. He becomes nervous and irritable and there is hypersensitiveness to light and drafts. At the end of two or three days there is some difficulty in swallowing with stiffness of the neck muscles. The fear of water develops early as the attempt to swallow produces marked reflex with spasms of the glottis, neck and jaw muscles. Following this there are attacks of convulsions which affect first the muscles of the neck and throat and then involve the whole body, causing symptoms resembling tetanus. The attacks occur intermittently, excitement increases and periods of hallucination and delirium ensue in the intervals. Death may occur suddenly from heart failure at any time during this period or the patient may pass into the paralytic stage, become comatose and die within twenty-four hours.

Paralytic or dumb rabies is rare in the human. The first symptom is paralysis, the limbs feel heavy, and quickly a condition of progressive paralysis develops.

**Diagnosis.**—Hydrophobia must be distinguished from a hysterical condition simulating the true disease, and from tetanus. The former may usually be excluded by the length of the incubation period and by the fact that the symptoms are amenable to suggestion. In tetanus there is more or less continuous tonic spasm between the attacks and the muscles of mastication, not those of deglutition, are chiefly affected.

**Symptoms in the Dog.**—There are two types, the more frequent, known as "furious rabies," and the "dumb" or paralytic rabies. In the former the character of the dog becomes changed, he is either more or less affectionate. He appears restless, always on the move or he may be dull and hide away. His appetite is abnormal and he becomes morose, snapping at things and animals. He scrapes incessantly, has difficulty in swallowing, wanders from home and returns exhausted and miserable. Soon spasmodic seizures begin, his bark is changed and saliva drips but he may not "froth at the mouth." This stage passes gradually into that of

paralysis and the animal dies in from four to eight days from the onset. In the paralytic form the first symptom is paralysis, often of the under jaw.

**Pathology.**—The organism has not been discovered. The macroscopic changes at necropsy are not characteristic. There are, however, certain microscopic bodies, known as Negri bodies, which are found chiefly in the larger cells of the nervous system, which have proved to be morphologically specific. The diagnosis in a suspected animal which has been killed depends upon the finding of these bodies. Occasionally these bodies are not found but rabies may be produced by animal inoculation. It is said that in all such brains there are suspicious small bodies and such cases should be treated as rabies until the result of animal inoculation is known.

**Prognosis.**—There is no proven instance of recovery in human beings after symptoms have appeared.

**Treatment.**—*Local.*—The immediate treatment of a bite from any animal is of great importance. When the bite is upon the face or neck or upon an exposed bare surface of the body, this is particularly true. Excision of the wound, if possible and if not, the inducing of free bleeding followed by mechanical cleansing should be carried out at once. The wound is then cauterized with fuming nitric acid, or if this is not available, with the actual cautery. It would seem scarcely necessary to say that the primary suture of dog bites should not be attempted, and yet not infrequently the bad results from such a procedure are met with. This treatment may be modified where the injury is slight and has been caused by a dog which appears healthy and which is known, with reasonable certainty, not to have been in contact with suspected animals.

*Constitutional.*—Since 1885 the Pasteur treatment has been in use and the success of the method makes it imperative that every patient suffering from the bite of a rabid animal should have treatment instituted at the earliest possible moment. The principle of treatment consists in the establishment of active immunity during the period of incubation by means of an attenuated virus. The criteria on which the decision to institute treatment rests are quoted from an article by A. W. Williams:

"Treatment should be advised therefore under any of the following conditions: (1) When the biting animal gives a definite evidence of rabies. (2) When the animal can not be found just after biting. This is always a suspicious symptom when no facts can be learned to account for it. (3) If the biting animal has been killed too early to give clinical or microscopic evidence of rabies or if its brain is in too bad a condition for immediate diagnosis, pending the results of inoculation of test animals. If these test animals show no symptoms in twelve days the treatment may be stopped, to be begun again if the animal shows symptoms later. (4) If the animal

is apparently healthy or has only suspicious symptoms it should be kept under observation for at least three weeks and treatment should be begun if suspicious symptoms appear or become more marked. (5) If the animal has been killed and no evidence can be obtained for or against rabies, treatment should be advised in areas where rabies is prevalent. (6) If anyone has been exposed only to suspicious animal saliva unless infected cuts or abrasions can be ruled out, treatment should be advised."

During the course of the treatment patients may show erythema about the points of injection and the patients' general health may suffer. Treatment should not be omitted, however, unless such symptoms become excessive. However, it should be remembered that the treatment is a serious undertaking and should be carried out, if possible, under the supervision of those with special experience in the procedure. The matter, fortunately, is now generally in the hands of the boards of health. Whenever the prophylactic immunization of dogs can be put upon a practical basis an important step in the extermination of rabies will have been taken. When the symptoms have once developed they can only be palliated. The patient must be kept absolutely quiet and free from all sources of irritation.

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## CHAPTER III

### BURNS AND SCALDS

It is unfortunately true that burns and scalds in young children seem to occur as frequently now as they did in the days when artificial lighting was largely by means of an open flame. Approximately one-third of such accidents occur in children under ten years of age. The great suffering, the alarming mortality, and in the event of survival, the disfiguring and disabling scarring make such accidents a matter of great importance to the community. The outlook of burns in young children is much more serious than in later life. The skin and deeper tissues are so much more delicate in the child than in the adult that they are damaged in a shorter time and also by a less degree of heat. Furthermore, the proportionate surface involved is so much greater in the small body. There is little difference in the effect which different kinds of heat have upon the tissues. Scalds are apt to be more frequent and are more extensive than burns as the fluid has a tendency to spread rapidly. On the other hand, they are apt to be more superficial from the rapid cooling. In burns the heat is generally applied to a more limited area and for a longer time resulting in a less extensive but deeper injury. Tissue damage from strong caustics is almost identical with that from heat. Similar lesions occur also from electricity and the Roentgen rays.

**Clinical Features.**—The classification of the local lesion is based upon the depth of the tissue involved and the one formulated by Dupuytren has been widely accepted: (1) Hyperemia, (2) vesication, (3) partial destruction of the skin, (4) complete destruction of the skin and subcutaneous tissue, (5) charring of muscle, (6) charring of bone. There is little practical advantage in such a classification and the lesion met with always illustrates more than one of the degrees. The clinical picture is therefore made up of the combined characters of some or all. The extent and severity of a burn almost invariably prove to be greater than appears at first sight.

The surgical history may be divided into four periods:

1. *Shock.*—A certain amount of shock is inevitable with a burn of any extent. This may be so slight as to be scarcely appreciable or may result in death within a short period. The symptoms are the usual ones of surgical shock. While in general the larger the burn and the younger the child the more serious is the resulting shock, it is noteworthy that

occasionally a relatively small and superficial burn will result in a disproportionate degree of shock. Burns over the chest and on the trunk are apt to be associated with greater shock than those involving the extremities. As a result, probably, of the greater degree of pain in superficial lesions they are apt to show a greater degree of immediate shock than when there is a deeper destruction of tissue.

2. *Reaction.*—When death does not immediately ensue there is usually a period of reaction during which the general appearance is good. There is a moderate rise in temperature and while the pulse is rapid it is of good quality. This stage may last several days and it is during this period that one must be careful in forecasting the future as the outcome is often not as favorable as the general appearance seems to indicate.

3. *Toxemia.*—Following this stage and often marked by a considerable rise of temperature, the symptoms of toxemia begin to be manifested. This condition probably results from the absorption of some products of protein autolysis at the site of the burn. The child is restless, skin clammy and slightly cyanotic. There is increased nervous irritability, delirium may follow and convulsive seizures of varying intensity are not uncommon. There seems to be an analogy between the toxemia of burns and that of intestinal obstruction. Associated with the burn there may be inflammatory conditions of the internal organs, often those underlying the area of the skin involvement. Such clinical complications as pleurisy or bronchopneumonia occur in burns of the chest; meningitis or edema of the brain when the head and neck are involved. Persistent diarrhea may be a feature in burns of the abdominal wall. Suppression of urine may occur as a complication in an extensive burn in any region. During this period there is apt to be a concentration of the blood with high hemoglobin and increased number of red cells. This means a failing circulation and an inefficient oxygen carrier. If there is much infection of the lesion the features of septic absorption may complicate the picture of toxemia.

4. *Recovery.*—If the outcome is favorable there is a gradual subsidence of symptoms and a period of convalescence depending upon the depth or extent of the lesion. As the general condition improves the local lesions become more healthy in appearance. In first and second degree burns healing is spontaneous, while in lesions of greater depth or of any considerable extent, skin-grafting is usually necessary.

**Prognosis.**—The chief factors in prognosis are age, extent, and situation of the burn.

*Age.*—The younger the child the more serious is the outlook. In infants a burn of any extent should be considered serious.

*Extent.*—The area involved rather than the depth of the lesion is the important factor. For this reason scalds, which are liable to be extensive

but superficial, are more serious than burns. Various estimates have been given of the extent of a burned area beyond which recovery is impossible. Any burn involving 10 per cent of the skin surface is serious and where 15 per cent is involved recovery is unlikely. These figures are based on the results from the older methods of treatment and it is hoped that with the advent of the use of tannic acid in the treatment of burns results will be materially improved.

*Situation.*—Involvement of the chest and trunk is more serious than that of the extremities. Most of the deaths occur within the first seven days. Persistent vomiting and convulsions are ominous signs. Repeated estimates of the relative concentration of the blood are of great value in prognosis.

**Treatment.**—*General.*—On admission, a dose of codein or, in older children, morphin should be administered and repeated as often as neces-

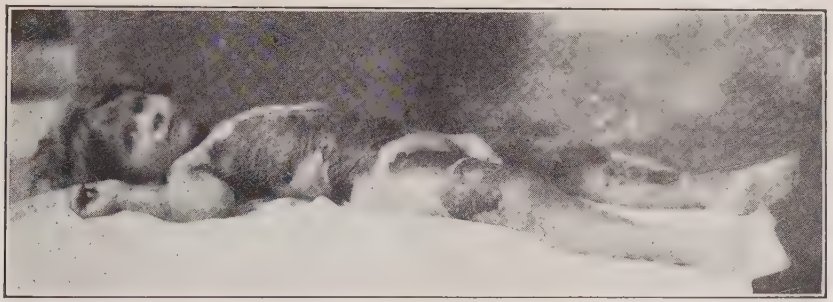

Fig. 1.—Extensive Severe Burn in Four-Year-old Girl Treated with Tannic Acid, Day after Injury.

sary to relieve pain. Body heat should be maintained by means of hot-water bottles, or an electric cradle or both. The forcing of fluids should be begun at once by mouth, rectum and hypodermoclysis. By this means not only is concentration of the blood diminished but any toxins are diluted and their elimination hastened. In severe cases transfusion is of the greatest value and should be carried out at once. Ordinary hypodermic stimulation is probably of little value. The analogy between the toxemia of burns and that of intestinal obstruction has been pointed out and evidence adduced to suggest that there is retention of sodium chlorid in the tissues. On account of this altered sodium chlorid metabolism normal salt solution is used for intravenous, subcutaneous and rectal administration.

*Local.*—The treatment of the local lesion in burns has always been unsatisfactory. That this is undoubtedly so the multitude of methods of treatment in vogue clearly indicate. Recently E. C. Davidson of Detroit, in the suggestion of the application of tannic acid, has apparently made a noteworthy contribution to the therapy of burns. Davidson says, "If the

toxemia of burns is due to the absorption of some protein derivative at the site of the burn then it would seem that a rational procedure would be some form of local therapy that would prevent this action. . . . Tannic acid is another such coagulant which forms more or less stable compounds with the

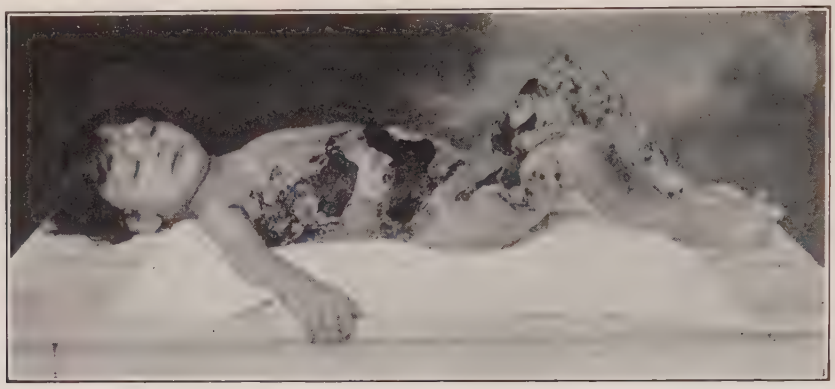

Fig. 2.—Same Patient as in Figure 1 Two Weeks Later.

protein of the body fluids. When it is applied to a burned surface in dilute solution further penetration into the deeper lying protoplasm is apparently prevented by this action and the true astringent effect appears limited exclusively to the most superficial layers of tissue."

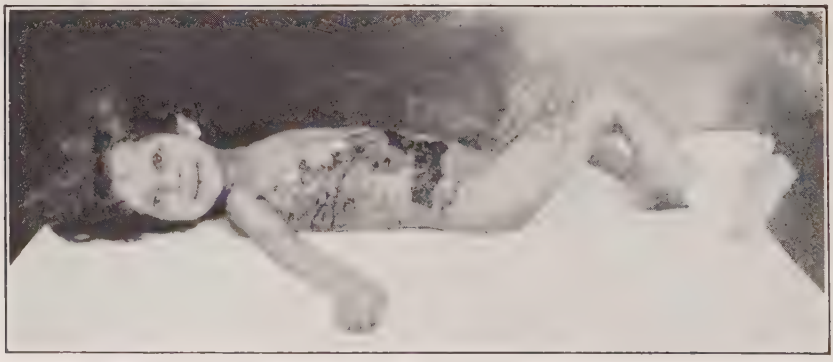

Fig. 3.—Same Patient as in Figure 1 Twenty-five Days after Injury.

Davidson's method consists in application, to the burned area, of compresses saturated with a 2.5 per cent freshly prepared aqueous solution of tannic acid. Continuing in the words of Beck and Powers who have applied this method and who have suggested a slight modification in application which seems to be an improvement, "An innocuous coagulum is thereby produced, which, when exposed to dry air, forms a parchmentlike surface over the burn. This protective covering renders the area insensi-

tive and prevents the loss of body fluid. . . . Coagulation of the burned tissue should be accomplished as rapidly as possible. A more intimate contact between the burn and tannic acid can be produced by spraying the burn frequently by an atomizer containing the solution. The burn is covered with a fine spray every half hour until the surface becomes brown or black. Blebs are opened as soon as they form and the epidermis is removed wherever it separates. An extensive burn can be coagulated completely in sixteen hours. If the burn involve the eyes, nose and ears, these parts can be treated readily by a fine spray of the solution. The coagulum should be dried as soon as possible. If the burn involve the subcutaneous tissues several days may elapse before the surface becomes dry. . . . The ordinary electric heater facilitates drying." After the toxemia has disappeared the next question is as to what to do with the coagulum. In superficial burns epithelization proceeds beneath the crust, which affords an excellent protection for the growing epithelium. The crust in such burns should not be disturbed and in about two weeks it will separate, revealing a healed surface. In deeper lesions the crust remains firmly adherent and as the growth of epithelium proceeds only from the periphery it may be advisable to remove the crusts after two weeks and graft the underlying granulating area. When there is a collection of pus beneath the crust as indicated by a secondary rise in temperature, it may be necessary to afford an exit for the pus by partial or complete removal of the crust. When the entire circumference of a limb is involved it may be necessary to make vertical incisions to the deep fascia so that the circulation is not impeded. The crust may be softened by the application of vaselin. The solution used should be freshly prepared. The

FIG. 4.—SAME PATIENT AS IN FIGURE 1 TWELVE WEEKS AFTER INJURY.

strength varies in the hand of different observers from 2.5 to 5 per cent, the advantage of the stronger solution being in the more rapid formation of the crust. The advantages of the method are the lessening of toxemia, the ease of application and the simplicity of the subsequent care of the patient together with the marked freedom from discomfort. I have had no personal experience with this method in burns about the eyes and I would hesitate to use it in this region.

Immediate débridement of the burned area has been advocated and may be useful in deep burns of limited area. Another method is the careful cleansing of the burned area under anesthesia with sterile soap and water and a brush or gauze sponge followed by salt solution. The wound is

Fig. 5.—Burn of the Buttocks Treated with Tannic Acid.

dressed with sterile gauze which is not disturbed for several days. The application of dressings kept constantly wet with a solution of picric acid is a popular method of treatment. The solution is made as follows: Picric acid 1½ drams; alcohol, 95 per cent, 3 ounces; water 40 ounces. Dressings of boric ointment or sterile petrolatum find their chief use in superficial or small area burns. Unless the future reveals some distinct disadvantages to the use of tannic acid this method would seem to be the best for the primary treatment of burns. When old or neglected cases come for treatment the infected granulating surface should be treated as any other similar wound—careful daily dressing, the application of moist antiseptic dressings and intermittent irrigation after the Carrel-Dakin method. When all sloughs have separated and a clean, firm granulating area remains, skin-grafting after the method of Thiersch is indicated at the earliest possible moment. There is no better way to prevent or minimize contractures than to ensure prompt wound healing with as little infection as possible. If further plastic operations are indicated they can be carried out to greatest advantage in the presence of a healed surface. Where there is probability of contracture in a burn involving an extremity it is better to secure frequent manual extension of the limb than to apply constant traction.

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## CHAPTER IV

## DEHYDRATION; SURGICAL SHOCK; ACIDOSIS; ALKALOSIS

### DEHYDRATION

When the amount of water ingested, plus that produced through metabolic processes, is less than that eliminated from the body, dehydration occurs. Every metabolic process in the organism is dependent on the presence of an adequate amount of water properly distributed. Experiments have demonstrated that a diminution of 10 per cent of the water content of the body results in serious symptoms, while a reduction of 20 per cent results in death. The body possesses an available store of a large amount of loosely bound water which exists chiefly in the skin and subcutaneous tissue, the muscles and the liver. This store can be drawn upon before there is evidence of any considerable degree of desiccation of the blood. It is only when the blood shows increased concentration that the serious symptoms of dehydration occur.

Excessive loss of water from the tissues and blood may result from many causes at all ages. The condition is, however, most frequent in infancy and early childhood and its recognition and adequate treatment is peculiarly important at this period. A rapid loss of water results from diarrhea, vomiting, high fever, wounds and burns, failure to offer a child sufficient fluid or from refusal of that offered.

The earliest evidence of dehydration is the loss of elasticity of the skin. This is demonstrated by pinching up a fold of skin. Under normal conditions the skin is elastic and, when released, returns quickly to its normal level. In dehydration the fold of skin is putty-like in consistence and tends to remain heaped up.

**Treatment.**—The indication is to restore the water balance to normal. In only the very mild degrees can this be accomplished by administering water by mouth. At this period of life proctoclysis is uncertain and not to be depended on. There remain hypodermoclysis, intraperitoneal injection and intravenous infusion. In the degrees of dehydration ordinarily observed, hypodermoclysis of physiologic salt solution or of 3 per cent glucose in salt solution in amount of 80-300 cc., depending on the weight of the infant and repeated two or three times a day as indicated, is usually sufficient. The intraperitoneal injection is advised by many authors as being superior to hypodermoclysis. I have had little experience with this method and prefer

hypodermoclysis. When concentration of the blood has existed for some time, with resulting destruction of red blood-cells, the parenteral administration of fluid may fail to restore the blood to its normal volume. This condition requires a preliminary transfusion of whole blood to bring about the assimilation of the fluids injected subcutaneously or intravenously. A low percentage of hemoglobin also hinders appropriation of fluid and necessitates transfusion. In extreme degrees of dehydration, when the patient may succumb before the water deficit can be restored sufficiently to influence blood concentration, Schloss has advised the intravenous injection of a 10 per cent glucose solution in amounts of 20 c.c. per kilo of body weight. It is essential that the intravenous injection be preceded by a subcutaneous or intraperitoneal injection of isotonic salt solution. If this is not done the intravenous injection will probably do harm rather than good. The treatment may be repeated in five or six hours. The change often wrought in an apparently moribund dehydrated infant by transfusion of whole blood and the judicious administration of repeated hypodermoclyses of saline or 3 per cent glucose in saline solution must be seen to be appreciated.

## SURGICAL SHOCK

Surgical shock is a state of profound depression of all the vital functions of the body. The exciting cause is practically invariably traumatic, but the effect of this factor is augmented by anything that tends to lower the vitality, such as hemorrhage, cold, starvation and sepsis. Functional depression of the vasomotor center from mental disturbance results in a condition resembling shock and known as collapse.

The outstanding feature in the clinical picture is a marked fall in the arterial blood-pressure resulting from a reduction of the volume of the blood in active circulation due to capillary stasis. On account of insufficient oxygenation a diminution in the alkaline reserve of the blood occurs, but this acidosis is the result and not the cause of shock.

**Clinical Features.**—The patient is profoundly prostrated and apathetic. The skin is pallid, slightly cyanotic, moist and cool, the features are drawn and the eyes sunken. The pulse is rapid, of poor quality, often all but imperceptible at the wrist; the respiration is shallow, sighing and irregular. The temperature is subnormal and there is little sensibility to pain. The condition usually appears suddenly but may develop gradually. Except in severe cases shock tends to recovery and after a few hours reaction sets in, the color improves, the pulse becomes full and the respirations deep and regular. When the condition is progressive all the symptoms are exaggerated, the patient lapses into unconsciousness and death follows. The child is more susceptible to shock than the adult and the condition pro-

gresses more rapidly. On the other hand, the child reacts more quickly to treatment.

**Diagnosis.**—Shock may usually be recognized by the clinical features and the fall in blood-pressure. In certain cases the symptoms of shock blend with those resulting from hemorrhage or toxic absorption and it is difficult to estimate the relative importance of the various factors.

**Treatment.**—In children about to undergo operations the likelihood of the development of shock may be greatly diminished by proper measures of precaution. No purgatives are given. An adequate amount of food and fluid is given to within a short time of operation. If the fluid intake is inadequate it is supplemented by hypodermoclysis in infants or retention enema in older children. Loss of body heat is avoided. The anesthetic is chosen carefully and administered skillfully. The operation is completed with as little loss of time as is possible and the utmost gentleness is used in each procedure. Loss of blood is avoided by prompt and exact hemostasis. The condition of the patient during operation may be followed by repeated observations of the blood-pressure.

When shock has become apparent the patient is placed in the recumbent position with the foot of the bed elevated. He is surrounded with hot blankets and hot-water bottles or heat is applied by means of the electric light cradle. If the shock is moderate a hypodermoclysis of saline solution or 3 per cent glucose in saline is given. During the administration of the hypodermoclysis great care is observed to prevent the loss of body heat. In severe cases, and in those associated with hemorrhage, a transfusion of blood is the most efficient treatment. Failing this an intravenous infusion of saline solution is given. Whisky or brandy may be administered in small amounts for its use as a body food and, if possible, carbohydrate food in the form of cereal gruels is given. Rest must be obtained and, if necessary, sleep is induced by small doses of codein or morphin. Hypodermic stimulation is of little avail but camphor may be used as a temporary stimulant.

## ACIDOSIS

The reaction of the blood-plasma and the tissues of the body is slightly alkaline and a truly acid state of the body never occurs. This reaction remains remarkably constant and one of the most active mechanisms in the body is that which tends to keep the alkalinity of the blood at its normal level.

During the course of normal metabolism, considerable amounts of acids are produced, such as carbonic, phosphoric and sulphuric, as well as certain organic acids. Under normal conditions the body is able to eliminate these

acids or neutralize them. As soon as the blood shows a marked increase in the amount of acid in proportion to alkali, serious symptoms arise and death usually occurs. Acidosis is the term applied to a diminution of the alkaline reserve of the blood and while a diagnosis is often made, the condition is actually rare. Ketosis is a special type of acidosis dependent upon the retention in the blood of the acetone or ketone bodies. This is the form of acidosis which occurs in diabetes, in so-called cyclic vomiting in children and in certain other conditions. A sharp distinction must be drawn between acetonuria and acidosis. Acetonuria merely means that acetone bodies are being excreted in the urine. This is a common finding in the urine of sick infants and children and may be of little or no clinical importance. It occurs with starvation, in many obscure infections and often after general anesthesia. When, however, acetone bodies are present in large amount in the urine the other evidences of acidosis should be looked for. One must not lose sight of the fact that acidosis due to the acetone bodies is only one of several types and that severe and fatal acidosis may occur when there is no overproduction of acetone bodies and when they cannot be found in the urine. It is only by the presence of characteristic symptoms and by chemical analysis of the blood that a diagnosis of acidosis may be made with certainty.

There is, in children, a special predisposition to the development of acidosis and certain symptoms are suggestive. At first there is restlessness and sleeplessness, later tending to drowsiness and coma. Flushing of the cheeks and cherry-red lips may, or may not, be present. Where the acidosis is due to acetone bodies, the breath may have a peculiar aromatic odor which has been variously described and which is often difficult of recognition. The only clinical symptom of positive value, however, is hyperpnea or increased pulmonary ventilation in which the respiratory rate may or may not be increased but in which both inspiration and expiration are prolonged. This symptom may not be apparent in mild acidosis. When such a group of symptoms appears following an operation, acidosis may be suspected. A decrease in the carbon dioxid combining power of the blood as revealed in laboratory examination is the best evidence of the presence of acidosis.

**Prognosis.**—A true acidosis is always a serious condition. When once the symptoms are well developed death is the usual outcome. The outlook in that form due to the overproduction of acetone bodies is somewhat better than in those due to other causes.

**Treatment.**—In general, symptoms of postoperative acidosis do not appear when losses of fluid are made up by an ample water intake. The body does not need alkalies if given a chance to utilize its own alkali reserve by diluting the solvent. The best form of treatment is preventive: In diabetes the use of insulin, safeguarded when necessary with the intravenous admin-

istration of 10 per cent glucose; in other conditions the avoidance of starvation, a diet rich in carbohydrates and low in fats. Under all circumstances the administration of an adequate quantity of fluids, by mouth, when possible, if not, by hypodermoclysis of 3 per cent glucose in physiologic salt solution; in older children retention enemata of 5 per cent glucose are of value, 3 to 6 ounces being given every four hours.

Where symptoms are already present the administration of sodium bicarbonate in amounts sufficient to produce an alkaline reaction of the urine has been advised. When a sufficient quantity of the drug cannot be administered by mouth or rectum, intravenous injection of a 4 per cent solution is the best method. The subcutaneous injection of any solution of sodium bicarbonate is to be avoided as sloughing may result. The carbon dioxid combining power of the blood should be determined before the intravenous administration of sodium bicarbonate as alkalosis may be mistaken for acidosis. When the acidosis is due to ketone bodies the administration of alkali should be secondary to that of glucose. Glucose in 5 per cent solution subcutaneously and 10 per cent intravenously give the best clinical results. The addition of insulin in the proportion of one unit to 3 grams of glucose has been advocated and appears to be of value. Whatever treatment is used the administration of water in large amounts by all possible avenues is indicated.

## ALKALOSIS

Alkalosis is a little understood condition in which there is an increase of alkali in the blood and tissues. It may occur as the result of excessive administration of alkali, in pyloric obstruction, high intestinal obstruction and in hyperpyrexia. There is a tendency for the urine to become alkaline and there is an increase in the carbon dioxid combining power of the blood. Suggestive symptoms are nausea, vomiting and numbness, while in the severe forms there may be tetany and convulsions. Acetonuria may occur in the presence of alkalosis and for this reason does not necessarily indicate the administration of sodium bicarbonate. The treatment is not well established. The administration of dilute hydrochloric acid has been advised as well as the subcutaneous injection of physiologic salt solution.

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## CHAPTER V

## PREOPERATIVE CARE; CHOICE OF ANESTHETIC; ADMINISTRATION OF ETHER; PRECAUTIONS DURING OPERATION; POSTOPERATIVE CARE

### PREOPERATIVE CARE

Children stand starvation very badly and their metabolism is easily upset. It should be our endeavor to get the child to the operating table in the best possible condition and not weakened by starvation and purgation. Food is allowed to within three hours of the time of operation. Water is allowed freely to within two hours of the administration of the anesthetic, and in small amounts to within half an hour of that time. It is desirable that particular attention be given to the keeping up of carbohydrate nourishment for one or two days preceding. Additional cereal and orange juice furnish easy means of accomplishing this. In practically all cases routine urinalysis and a complete blood-count are desirable. Acetonuria is very common in children, particularly after they have been in the hospital for a few days. It rarely indicates acidosis but always merits consideration. The administration of a general anesthetic has a tendency to increase the production of acid bodies. For that reason in an operation of choice the presence of large amounts of acetone in the urine should cause the operation to be deferred until the error responsible for its presence has been corrected.

The administration of laxatives before operation is not only unnecessary but actually harmful. The bowel should be emptied by an enema from four to twelve hours before operation. In those cases in which operation is undertaken as an emergency no enema should be given.

Children are especially liable to infection and therefore much caution is necessary to exclude, if possible, the chance of the child being in the incubation stage of one of the exanthemata. In an operation in which the time is elective there should be delay until the incubation period is over if the child has been exposed. Furthermore, to subject an ill-nourished, anemic child to a surgical procedure which is not urgent may be disastrous. No operation of choice should be undertaken until every effort has been made to put the child in as good physical condition as is possible under the circumstances. The presence of anemia of any degree calls for a transfusion in the case of an emergency and for delay until the condition

has been corrected, in an operation of choice. The temperature should always be noted shortly before operation and a rise of one or more degrees calls for postponement unless the condition for which the operation is being undertaken explains the fever. Evidence of any respiratory infection is also an indication for postponement. In emergency cases no general preparation is indicated unless the patient is dehydrated or in a state of shock when measures appropriate for such conditions should be carried out.

## CHOICE OF ANESTHETIC

Anesthesia is much more frequently employed in the case of children than in adults. Its use is frequently essential to secure a satisfactory abdominal examination and is often indicated in painful dressings. In general, ether, administered by the open method, is the anesthetic of choice for routine use. Chloroform is pleasanter and more easily handled but its use is attended with much greater danger than is that of ether and is rarely justified. Ethyl chlorid, sprayed on the open ether mask, makes induction easier and may precede the ether. Nitrous oxid-ether sequence is desirable in older children when an experienced anesthetist is available. The value of nitrous oxid-oxygen and ethylene-oxygen anesthesia at all ages is receiving general recognition. When an expert anesthetist is available their use is often ideal.

In administering anesthetics to children it must be remembered that they are easily asphyxiated and quickly narcotized. The margin between a proper dose and an overdose is comparatively small. When a child is anesthetized in the prone position a support should be placed under each shoulder that there may be room for the expansion of the chest.

Whatever form of anesthesia is chosen the administration should be as gentle and humane as possible. In the case of infants, naturally there can be no mental preparation. With older children, however, it is often surprising how reasonable they are when the situation is explained to them. It is unwise to attempt administration while the child is in bed. The child should be brought to a room adjacent to the operating room and there anesthetized. The administration of atropin before the induction is of value in avoiding the accumulation of mucus. One-four-hundredth grain is a suitable dose for an infant under one year.

While local or regional anesthesia has a definite place, it is relatively little used in the surgery of children. In cases of congenital stenosis of the pylorus local anesthesia may be used with advantage, where the condition is poor, or where coincident upper respiratory infection makes the use of ether particularly dangerous. In empyema intercostal drainage may, with advantage, be carried out under local infiltration anesthesia. I have

not found the use of local anesthesia satisfactory where rib resection is to be done. Various minor operations may be done under local but ordinarily the use of general anesthesia is preferable.

## PRECAUTIONS DURING OPERATION

It is essential that the loss of body heat be guarded against. The temperature of the operating room should be 70°-72° F.; ventilation should be good but drafts must be avoided. In the case of infants the extremities may be bandaged in cotton wool and the child placed on a hot-water bottle or electric pad. It is particularly important to keep the field of operation and the entire child as dry as possible and the use of wet towels or pads must be guarded. Children do not stand prolonged operations nor the loss of blood. All manipulations should be gentle and hemostasis should be prompt and as nearly perfect as possible.

## ADMINISTRATION OF ETHER

A suitable mask, covered either with two layers of stockinet or an equivalent thickness of gauze, is provided. The ether is best administered from the original container, which should be so stoppered as to permit the rate of flow of drops to be easily controlled by the anesthetist. The odor of the ether may be disguised by a few drops of oil of orange on the mask. The child is told to blow out and while the mask is held away from his face ether is slowly dropped on various points of the cover. The mask is gradually lowered until the nose and mouth are covered and the rate of dropping is increased until the mask cover is moist. If the child holds his breath the mask is momentarily lifted and replaced as inspiration begins. Shortly a piece of gauze or a towel may be adjusted about the mask. After anesthesia is complete the ideal is a continuance of smooth, even, light anesthesia and this is best attained by the continuous administration of a sufficient number of drops of ether per minute. It is not desirable for the anesthetist to saturate the mask and then take up another occupation until the child shows signs of coming out when the mask is again saturated. Such anesthesia results in a constant succession of episodes when the child is either too deep or too light and is very trying, both to the patient and to the surgeon. It is not necessary to warm the ether vapor. It is very important that there be an adequate supply of air and any tendency to cyanosis must be corrected. The rate and quality of the pulse are carefully watched. When there is much mucus in the throat it is best removed by suction. Constant wiping out the mouth and throat with gauze tends to increase the quantity of mucus and trauma-

tizes the mucous membrane. While tongue forceps and a mouth gag should be at hand it is rare indeed that their use is indicated. Before the patient is returned to bed a drop of castor oil is placed in each conjunctival sac to allay any irritation that may have resulted from the ether vapor.

## POSTOPERATIVE CARE

After the operation is completed care should be taken that the skin is dry and the clothing warm and dry. In returning the child to the room, exposure to cold and drafts should be avoided. In the case of infants and feeble children it is well to have the head slightly lowered until they begin to recover. The bed should be warmed and well protected hot-water bottles placed in it. A child recovering from anesthesia should have the undivided attention of an intelligent nurse.

After operation vomiting may be expected but it is usually temporary in occurrence and mild in degree in children. Immediately upon recovery from anesthesia the mouth may be washed out and in two hours sips of hot or cool water, sweetened or plain, allowed. If vomiting persists a glassful of water given at once will often serve to wash out the stomach. Long-continued vomiting is best treated by gastric lavage. Pain may be allayed by the administration hypodermically of small doses of codein phosphate. It is better to give a small dose and repeat than to give too large a dose. Bromid of potassium or sodium by rectum, in suitable doses, is an excellent sedative. Until an adequate quantity of fluid is taken by mouth hypodermoclyses of 5 per cent glucose solution should be repeated as often as indicated. The administration of food may be begun after twenty-four hours and the quantity gradually increased until a regular diet is reached on the third or fourth day.

Abdominal distention is treated with hot stupes, rectal tube, enemata and rarely pituitary extract. Magnesia magma, in repeated small doses, is the best laxative but even this is used sparingly.

Postoperative retention of urine is exceptional in children. When catheterization is necessary in infants a ureteral catheter should be used.

The care of the mouth and teeth during convalescence is at least as important in children as it is in adults.

## CHAPTER VI

### TRANSFUSION

Transfusion is of peculiar value in pediatric surgery. It must be understood that the transfusion is given in addition to an adequate supply of fluids by mouth, rectum, hypodermoclysis or intravenous infusion as circumstances indicate.

**Indications.**—1. Hemorrhage, from any cause. Infants and children do not bear well the loss of blood. In severe hemorrhage transfusion is imperative. When the loss of blood is of less degree and not in itself immediately alarming, the period of convalescence is often materially shortened by transfusion.

2. Shock. Transfusion is often indicated as a prophylactic when a serious operation is anticipated. In existing shock it is indicated as the most efficient therapeutic measure at our disposal.

3. Severe dehydration and toxemia. Indicated in conjunction with hypodermoclysis and the intravenous infusion of glucose solution.

4. Hemorrhagic diseases (hemophilia, purpura hæmorrhagica, etc.). Any operation on a hemophiliac should be preceded by transfusion.

5. Toxemia of burns, intestinal obstruction, etc.

6. Acute and chronic infections. Of particular value in young infants whose mechanism for resistance to infection is not fully developed. Not only does transfusion tend to increase the resistance to an existing infection but it is the best means we have to combat the anemia which accompanies the severe infections.

7. Jaundice. Any operation of a jaundiced infant or child should be preceded by transfusion.

8. Long-continued starvation as in congenital stenosis of the pylorus.

**Precautions.**—The preparations for transfusion in an infant are the same and are just as important as in an adult. The donor must have compatible blood, be free from communicable disease and in good general health. It is also unwise to rely on blood-grouping alone and the final test must invariably be a direct matching of the blood of the donor and recipient. In the case of infants and children the problem of securing a donor is simplified by the fact that one or the other parent is often available. There is a fairly general belief that in the case of an infant the mother may be used safely without preliminary tests. Reliance on this assumption may lead to disaster. It is true, however, that the likelihood

of harmful reactions from transfusion in infants is much less than in adults.

**Dosage.**—From 7 to 10 c.c. per pound of body weight may safely be used.

**Methods.**—Direct transfusion of whole blood by syringe is the method of choice. I can see no advantage in the addition of citrate. The original Lindemann method is just as applicable in infants as it is in adults. In children over two there is little difference in procedure from that in adults. In infants it is usually necessary to cut down on the vein. Usually the internal saphenous vein at the ankle is most suitable. The veins at the bend of the elbow or the external jugular may be used. An incision 0.5 to 1 centimeter in length is made after infiltration of the skin with a few drops of 0.5 per cent procain. The vein is located, a portion freed by blunt dissection and elevated above the level of the wound edges by the passage of an artery forceps beneath it. A special cannula and obturator of about 20 gauge is inserted, either directly into the vein or after a small cut has been made with fine-pointed scissors. It may be necessary to tie the cannula in place. After the appropriate amount of blood has been delivered the cannula is withdrawn and the ligature removed. The wound in the skin is closed with one suture.

I have observed, for a number of years, a succession of residents at the Babies' Hospital rapidly acquire great facility in direct transfusion by way of the peripheral veins. I am convinced that the method is both practical and safe. I have had no experience with puncture of the longitudinal sinus and do not approve of its routine use as a means of introducing blood into the vascular system.

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## CHAPTER VII

## SURGICAL ASPECTS OF CERTAIN DISEASES OF METABOLISM

### SCURVY

Scurvy is a nutritional disorder due to the prolonged use of a diet lacking in one of the essential vitamins. The exclusive use of certain proprietary infant foods, sterilized milk, condensed milk or pasteurized milk may cause scurvy, while the addition of orange or tomato juice to the diet will promptly supply the deficiency. Some children are more liable to the development of the disease than others fed on the same diet. Early recognition and proper medical management practically invariably result in prompt cure. The importance, from a surgical standpoint, lies in the differentiation from certain other conditions.

More than four-fifths of the cases occur between the sixth and fifteenth months. The disorder is characterized by spongy, bleeding gums, swelling and ecchymosis about the joints and extreme hyperesthesia. Preceding these symptoms there is often elicited the history of a period of restlessness, irritability, pallor and failing nutrition, but tenderness of the legs is usually the first symptom noticed. If the urine is examined at this time a few red blood-cells will often be found. If proper treatment is instituted there is rapid improvement and permanent recovery. If, however, the condition is allowed to progress, the tenderness of the legs becomes exquisite and the swelling about the joints is great. The child lies motionless with legs and thighs semiflexed and hips rotated out. There may be ecchymosis about the joints. The mouth symptoms are rarely prominent unless there are teeth. In severe cases there is always some elevation of temperature. There may be bleeding from almost any of the mucous membranes, most frequently from the nose or mouth. There may be hemorrhage from the stomach or bowel. Epiphyseal separation may occur in the severe cases, most frequently involving the lower epiphysis of the femur or the upper epiphysis of the humerus. The most striking roentgenographic evidences of scurvy are a spindle-shaped thickening of the long bones, the result of subperiosteal hemorrhage, which sometimes extends over the entire length of the diaphysis and, proximal to the epiphysis, a heavy transverse line of increased density from which laterally projecting spurs may take origin. There may also be noted an area of diminished density in the region of the metaphysis. It is through this area of diminished resistence that the so-called epiphyseal separation takes place. The

FIG. 6.—ORBITAL HEMORRHAGE WITH EXOPHTHALMOS AS A RESULT OF SCURVY IN AN EIGHT MONTHS INFANT.

FIG. 7.—SCURVY IN A NINE MONTHS INFANT; SUBPERICRANIAL HEMORRHAGE.

Fig. 8.—Acute Scurvy in Nine Months Infant.

Early roentgenographic evidence of subperiosteal hemorrhage about lower extremity of femur with heavy transverse lines of increased density proximal to the epiphyses.

Fig. 9.—Same Patient as in Figure 8 Seven Weeks Later.

Fig. 10.—Same Patient as in Figure 8 Eight Months Later.

epiphyseal body itself usually presents a well-defined ring of increased density around a more rarefied central portion. If untreated the condition becomes one of grave anemia and death occurs. Rickets and scurvy are often associated and the bone changes characteristic of each may be observed in the same patient.

**Diagnosis.**—Diagnosis is based on the history of feeding, physical examination, roentgenograms and the response to antiscorbutic feeding.

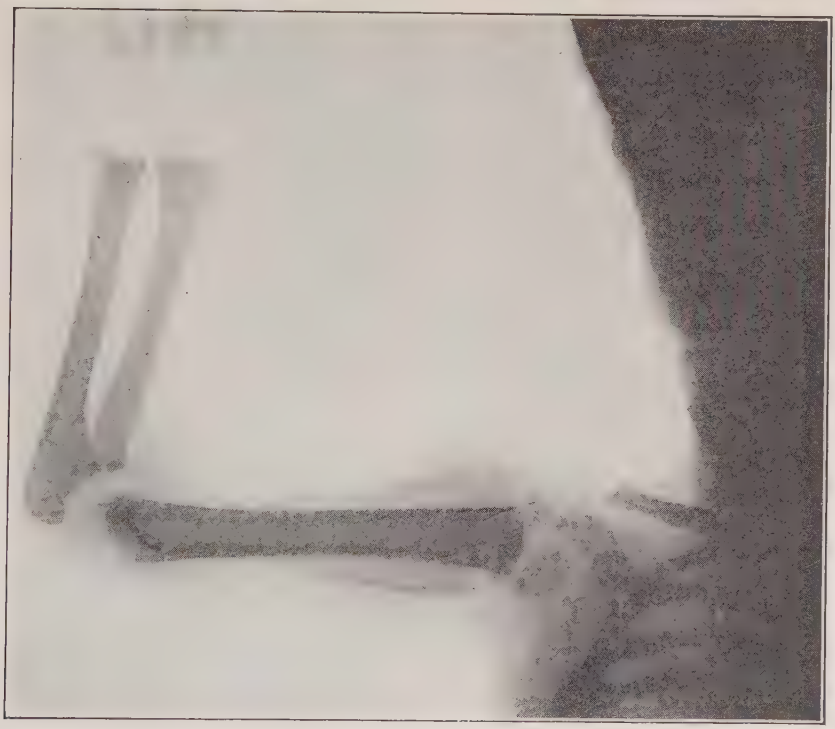

FIG. 11.—SCURVY IN EIGHT MONTHS INFANT.
Partial separation upper humeral epiphysis with subperiosteal hemorrhage.

*Differential Diagnosis.*—The disease with which infantile scurvy is most frequently confounded is rheumatism. Rheumatism is rarely observed under two years of age and a case of scurvy so advanced as to cause suspicion of rheumatism would have characteristic signs in the gums, subperiosteal hemorrhages and typical Roentgen ray pictures. Inability to move the limbs and ecchymosis naturally suggest trauma which may be ruled out by other symptoms, the roentgenograms and the response to the therapeutic test. Differentiation from osteomyelitis is important in avoiding an unnecessary as well as dangerous operation. Scurvy is usually bilateral and symmetrical, osteomyelitis is usually unilateral and associated

FIG. 12.—SCURVY AND RICKETS IN AN ELEVEN MONTHS INFANT.

Subperiosteal hemorrhage, transverse lines of increased density, spur formation and epiphyseal changes.

with high temperature and leukocyte count. In any case a roentgenogram is conclusive.

The late stage of the subperiosteal hemorrhage of scurvy has been mistaken for sarcoma. Careful examination usually discloses involvement of the opposite side as well as hemorrhages elsewhere. Where there is doubt the therapeutic test will be conclusive.

Syphilitic epiphysitis has certain points of similarity to scurvy. Scurvy, however, is very rare before the sixth or seventh month, while syphilitic epiphysitis is rare after the third month. Scurvy is usually bilateral, while epiphysitis is usually unilateral. Other signs of syphilis are present and the roentgenogram is characteristic for each. Hematuria may be an early symptom of scurvy and may suggest affections of the urinary tract. Hemorrhage into the wall of the bowel may form a tumor which is suggestive of that of intussusception.

## RICKETS

Rickets is a constitutional disease of nutrition due, probably, to some specific deficiency in the diet. The pathological changes may be widespread, but the chief and characteristic lesions are in the bones. The condition is of interest to the surgeon chiefly from the standpoint of diagnosis during its active period. During this period the treatment is appropriately a medical problem. With the sequelæ of the disease, those deformities of the skeleton which result from the earliest bony changes, the orthopedic surgeon is concerned. It is not intended to give a systematic discussion of the disease as this has been done elsewhere, but to refer to those points which should appear in every surgical case history, and which may aid in diagnosis.

Rickets is one of the commonest diseases of children and is most frequently observed between the sixth and eighteenth months. It rarely begins after the third year. The development of the disease is therefore at a period of rapid growth and all types of bones are affected. Its visible results are enlargement of the metaphyses of the long bones and of the centers of ossification. There is also a lack of rigidity of the shafts which results in deformities or fractures.

A form of the disease known as late rickets or the rickets of adolescence is occasionally met with in the period from nine to seventeen. This manifestation is believed to be due to a recrudescence of the condition which had existed in infancy. The changes are for the most part confined to the ossifying junctions most active during adolescence, particularly the knee-joint. It plays an important part in the production of those deformities which occur at or near puberty, especially knock-knee.

Fig. 13.—Rickets in a Ten Months Infant.
Changes at epiphyseal lines, subperiosteal fracture of fibula.

**Symptoms.**—In the early stages there is a general restlessness, excessive sweating and some abdominal enlargement. Delay in dentition is suggestive. The bones are tender and manipulation of the limbs is painful. Although rickets is due to some disturbance of nutrition rachitic babies are often fat. In such cases, however, the muscles suffer at the expense of the fat tissue. The flesh is soft and flabby and the movements are languid. There may be delay in walking. The anterior fontanel remains open. The head is enlarged and square shaped, due to enlargements at the centers of ossification, most marked in the frontal and parietal regions. The enlargement of the head from rickets and that from chronic internal hydrocephalus is sometimes confused. In hydrocephalus the enlargement is symmetrical and due to pressure from within, and the fontanel bulges, while in rickets the enlargement is irregular and due to deformity of the bones of the cranium. The cranial bones may be so imperfectly ossified that they can be indented on pressure.

One of the earliest recognizable signs is the so-called rosary. This is due to a series of rounded prominences or "beads" at the costochondral junction. As the ribs are relatively short at this period the rosary is situated farther from the midline than would be the case in an adult and may be overlooked on this account. Due to the softening the ribs may be pulled inwards, encroaching upon the lungs with a resulting prominence of the sternum and a vertical sulcus on either side. The lower ribs may project outward from the remainder of the chest.

The long bones show enlargements at the region of the epiphyseal lines and there may be bending of the shafts. There is swelling of the periarticular tissues and there may be fluid in the joint itself. The cartilaginous joint surfaces are intact. The metaphysis, however, becomes softened and spreads out, resulting in the characteristic thickening above the joints.

The roentgenographic appearance is characteristic. The ends of the bones are expanded, have an inverted saucer-shaped appearance, and the line of ossification is irregular. The epiphysis itself is intact, but its margin is indistinct and fuzzy as opposed to the well-defined margin of the epiphyseal body in scurvy. This saucer-shaped expansion is most evident in the lower ends of the tibia and the radius. There is, as a rule, no periosteal bone production.

As a result of these early changes the bone structure is so altered and its texture so softened that the skeleton yields to any pressure or pull and various deformities result. These deformities and their treatment have been described in detail in Volume VI on Orthopedics of Childhood. Until the end of the seventh month the rosary and softening of the cranial bones are the chief appreciable bony changes. Thoracic and other permanent deformities appear toward the end of the second year. Apart from the

Fig. 14.—Rickets in Child Two and a Half Years Old.
Very marked bony changes.

deformities there is a diminution in the longitudinal growth in the bones. Occasionally even after cessation of the active stage there is an almost complete cessation of growth with consequent dwarfing.

Rachitic bones are liable to fracture. Such fractures are usually subperiosteal and with little tendency to displacement of the fragments. Union is, however, frequently delayed and angulation may result. Where there are multiple fractures and marked atrophy from disease the condition may be mistaken for osteogenesis imperfecta. In this latter condition the atrophy is marked and there are many fractures, but there are no changes at the epiphyseal line.

The muscles are flabby and weak. As a result there is a delay in sitting up and there may be a general kyphosis which disappears when the baby is prone. This deformity is not to be confused with that from tuberculosis. Tuberculosis of the spine is uncommon in infancy and is associated with rigidity. Enlargement of the abdomen results from the weakness of the abdominal muscles and the dilatation of the stomach and intestines from the coincident disturbance of digestion so common in rickets. This condition may be extreme and has been mistaken for tuberculous peritonitis and congenital dilatation of the colon. It is extremely difficult at times to differentiate free peritoneal fluid from a distended intestine filled with liquid feces.

From the standpoint of the general surgeon the importance of the diagnosis of rickets consists in its differentiation from certain affections of the joints in infancy and the determination of the relative importance of an associated condition which may mask or be masked by rickets. The presence of the condition complicating some surgical disease may influence the choice of time for operation if indicated. In fractures the prognosis is affected.

**Prognosis.**—In the early stages, under adequate medical supervision, a rapid recovery is the rule.

## CHAPTER VIII

## SURGICAL ASPECTS OF CONGENITAL SYPHILIS

A striking feature of syphilis is that it may be transmitted from infected parents to their offspring, the children manifesting the signs that characterize the acquired form of the disease. The more recent the disease in the parent the greater is the risk of transmission, so that if either parent suffers from secondary syphilis the infection is almost invariably transmitted.

In congenital syphilis the infection is a general one from the outset and the spirochetes may be demonstrated in large numbers in the viscera and in the nasal secretion. The infection exercises an injurious influence on the fetus which often dies during the early months with a resulting miscarriage. Miscarriage may terminate repeated pregnancies, the date of each miscarriage becoming later as the mother's infection becomes attenuated. Eventually a child is born at term. It may be stillborn, or if born alive may suffer from syphilitic manifestations.

The manifestations of congenital syphilis are manifold and some of these manifestations are of particular interest to the surgeon. We are not concerned with the severe forms which prove fatal but with those milder forms in which the infant appears healthy at birth, but after a few weeks begins to show evidence of the disease. The recognition of inherited syphilis is particularly important, not only in the interest of the patient but also in that of the parents who may be unaware of having the disease themselves. Its recognition is also important that any one nursing or handling the child may be warned as to the proper methods of avoiding infection.

After a few weeks, usually three to eight, the child ceases to thrive, becomes thin and suffers from eruptions. Frequently there is a chronic rhinitis, known as snuffles, in which there is a thin nasal discharge which results in noisy breathing. In severe cases ulceration of the mucous membrane lining the nose occurs and affords entry for a mixed infection which may lead to destruction of the nasal cartilage and bones with resulting saddle-nose.

The skin eruptions are varied in type, but the most common is a papular disklike eruption, the papules being large, with a smooth shining top and of a reddish brown color. The buttocks, thighs and genitals are chiefly affected. At the anus the papules may acquire the characteristics of con-

dylomata. Ulceration may occur at the angle of the mouth which, on healing, leaves characteristic radiating scars. Suppuration about the nails, leading to their being shed, is sometimes seen.

Lesions of the bones are among the most important surgical manifestations. The earliest type occurs commonly before the third month. One or more limbs, usually the upper, appear paralyzed (pseudoparalysis

Fig. 15.—Luetic Epiphysitis in a Three Months Infant.
Characteristic saw-tooth irregularity.

of infancy). Any attempt at movement causes pain and tenderness may be demonstrated at the ends of the long bones, especially those about the elbow. A definite thickening may be made out in this situation. Birth injury may be differentiated by the fact that normal movement has preceded the apparent paralysis. Pyogenic infection is accompanied by visible swelling and fever. The roentgenogram is characteristic. There is marked disturbance on the diaphyseal side of the epiphyseal line with localized areas of softening and destruction of bone just beneath the periosteum. These areas are circumscribed, appear "gouged out" and extend from the epi-

physeal line into the bone proper. The epiphysis itself appears normal in density and outline. There is always new periosteal bone. Recovery takes place under antisyphilitic treatment and immobilization.

The phalanges may be similarly affected, producing syphilitic dactylitis. The finger is swollen and thickening may be made out along the phalanx. The appearance closely resembles that of tuberculous dactylitis, but occurs in early infancy when tuberculosis is most uncommon. A roentgenogram reveals the thickening to be mainly subperiosteal, while in tuberculosis the interior of the bone is affected. In doubtful cases the Wassermann reaction or the results of specific treatment determine the diagnosis.

Fig. 16.—Luetic Epiphysitis and Periostitis, Infant Two Months Old.

Another lesion occurring commonly in infancy is syphilitic orchitis. The testicles are usually symmetrically enlarged and are not tender or painful. Tuberculosis of the testicle is rare in infancy and affects the epididymis, while syphilis affects the testicle proper.

In childhood, commonly after the sixth year, there is another group of lesions which, in a general way, resemble tertiary manifestations of the acquired disease. Areas of osteoperiostitis are common in the long bones. The tibia is commonly affected and is enlarged and thickened, resulting in a characteristic saber-shaped deformity. The condition may be associated with nocturnal pains or may be quite painless. Less commonly there is a painless thickening of the end of one of the long bones. The roentgenogram reveals a lesion which resembles that of tuberculosis. The bone is generally enlarged with numerous irregularly disposed areas of softening.

Joint lesions, during infancy, are almost unknown except as a synovitis

secondary to diseases of the end of the bone. In childhood, however, commonly in the period from five to twelve, there may be symmetrical, painless synovitis accompanied by an excessive amount of fluid. Immobilization should be associated with the regular specific treatment.

Among the most characteristic signs of the disease is interstitial keratitis, which may be associated with iritis. The tapering or peg-shaped

Fig. 17.—Luetic Periostitis Metacarpal Bones, Infant Eight Months Old.

permanent upper central incisors with the deep notch at their cutting margin are characteristic and are associated with the name of Hutchinson who described them.

Diagnosis depends on parental history, clinical manifestations in the child, the Wassermann complement fixation test and the results of treatment.

Prognosis should be guarded and depends upon the period at which symptoms appear and the intensity of the manifestations of disease. The later symptoms appear the better the prognosis.

The methods of treatment will not be entered into as they have been amply discussed elsewhere.

BOSTON MEDICAL

# CHAPTER IX

## SURGICAL ASPECTS OF CERTAIN DISEASES OF THE BLOOD

### THE BLOOD IN INFANCY AND CHILDHOOD

**Red Corpuscles and Hemoglobin.**—The number of red cells and the percentage of hemoglobin is higher at birth than it is at any other time of life. On the first day the hemoglobin percentage may be 110 to 120 or even higher, the number of red cells 5,500,000 to 7,500,000. The percentage of hemoglobin rapidly falls and at six months is about 70 per cent, gradually increasing thereafter to reach the normal figure at six years. The number of red cells gradually diminishes until the adult standard is reached at six years. Nucleated cells and variations in size and shape of the red cells and in the staining qualities appear with less provocation in young children than in adults.

**White Corpuscles.**—There is a polynuclear leukocytosis at birth and for a few days thereafter. Within the first week there is a drop to 12,000 to 14,000, at which figure it remains for six months. After the first week lymphocytes predominate. For the next eighteen months the normal number of leukocytes varies from 10,000 to 12,000 with 40 to 50 per cent lymphocytes and 35 to 45 per cent polynuclears. During the next four years the numbers gradually change until the adult standards are reached.

**Blood-Platelets.**—While the blood-platelets are increased during the first few days, during the rest of infancy and childhood they remain at about the same figures as in adult life.

**Leukocytosis.**—Leukocytosis occurs in infancy and childhood under the same circumstances as in adults. It is likely to develop more quickly and to be more marked than in later life. While the investigation of the blood should always be carried out, the results of such investigations are of less value than in adult life. Leukocytosis is the rule in all conditions in which there is an acute inflammation. It is particularly marked in inflammation of the upper respiratory tract and in pneumonia, erysipelas, scarlet fever, primary peritonitis and in varying degrees in all suppurative conditions. There is usually no increase in malaria, typhoid fever, measles, German measles, mumps, influenza and tuberculosis. When tuberculosis involves the meninges, and also the peritoneum, there may be a leukocytosis. In estimating leukocytosis the normal high proportion occurring in the blood of children must be remembered. There may be a true lymphocytosis in

whooping-cough, scurvy, rickets, congenital syphilis, malaria, and in lymphatic leukemia.

**Anemia.**—The treatment of the various types of anemia is of course primarily medical. All types of anemia, however, benefit from transfusion of blood. Preliminary to operation in splenic anemia and in any secondary anemia transfusion is of the greatest value.

**Purpura.**—Extravasation of blood into the tissues may accompany many conditions and manifests itself by hemorrhagic spots in the skin. When these spots are small they are called petechiæ; when larger, purpuric spots. They may vary from a pin point to a large hematoma and in color from red to black. Visceral hemorrhages and bleeding from the mucous membranes may accompany the skin manifestations. Purpuras may be grouped into symptomatic and idiopathic types.

*Symptomatic Purpura.*—Symptomatic purpura is very common and may be an incident in the progress of many diseases. Purpuric eruptions may occur in the course of many of the infectious diseases, in jaundice, in scurvy, in syphilis, in severe anemia, in marked nutritional disturbances especially in infancy, and are often due to drugs, among which are iodin, arsenic, mercury, coal tar products and quinin.

Treatment.—Treatment of the original disease is, of course, essential but where purpura is severe immediate benefit may be derived from blood transfusion.

*Idiopathic Purpura.*—Idiopathic purpura is not uncommon in childhood. Presumably the hemorrhages are due to changes in the blood-vessels and these changes are toxic in origin. There is usually a slight elevation in temperature and more or less systemic disturbance. When the hemorrhages occur only in the skin the condition is called purpura simplex. When there is, in addition, pain and swelling about the joints, the name of purpura rheumatica is applied. When hemorrhage occurs into the intestinal wall the condition is spoken of as Henoch's purpura. The hemorrhage into the bowel wall may precede those into the skin and the differentiation from acute intussusception may be difficult when this happens. There may be acute abdominal pain and tenesmus with blood-stained, frequent stools and a tender mass in the abdomen. Swelling and pain in the joints and the appearance of a petechial eruption aid in making a diagnosis. It must be remembered also that very rarely the hemorrhage into the intestinal wall may serve as the starting point of an intussusception.

Treatment.—Treatment is entirely symptomatic as drugs have no effect. In the mild cases little treatment is indicated. Transfusion is almost invariably successful and is indicated in all cases of any severity.

*Purpura hæmorrhagica or Essential Thrombocytopenic Purpura.*—Essential or idiopathic purpura hæmorrhagica, or better, thrombocytopenic

purpura, has been differentiated from the general group of purpuric diseases. Its pathogenesis is uncertain, though the most popular theory is that of infection. The disease is not hereditary. It occurs chiefly in youth and adolescence and is sometimes seen in early childhood. Exact diagnosis is usually possible, though it is sometimes very difficult to differentiate from aplastic anemia with hemorrhagic features.

The first manifestation is the appearance of purpuric spots in the skin of the entire body. Ecchymoses follow on the slightest trauma. Frequently there is bleeding from the nose, gums and uterus, less often from the intestinal or urinary tract. Attempts at control of the bleeding meet with little or no success. Transfusion of blood and intramuscular injection of whole blood are sometimes temporarily successful. Radiotherapy over the spleen has been effective for varying periods.

The course may be intermittent or continuous. Death occasionally takes place in two or three days. In other cases, after weeks or months of illness, the symptoms disappear without apparent cause, to recur at some later date. Spontaneous cures have been seen. Fever may be present in any of these forms.

Certain characteristic features are revealed in an examination of the blood. First in importance is a diminution and occasionally an entire absence of the blood-platelets or thrombocytes, of which there are normally present about 250,000 per cubic centimeter. The blood clots normally, in this respect differing from the blood in hemophilia. There is, however, no retraction of the blood-clot. In this condition the normal bleeding time of one-half to three minutes after skin puncture is prolonged to eight or more minutes. There is no increased fragility of the red cells. Secondary anemia, in a degree depending upon the amount of blood lost, is of course present. The number of white cells is usually neither increased or diminished, though leukocytosis is very occasionally seen. The tourniquet test is positive. The spleen is often palpable, though usually not greatly enlarged.

In the subacute and chronic forms splenectomy appears to be a curative measure. It is indicated only in well-defined cases and is not to be considered in symptomatic purpura. The mortality of the operation is about 5 per cent. Direct transfusion of blood is often of value in preparation for the operation. After splenectomy, bleeding usually ceases promptly and the blood-platelets are greatly increased in number. Subsequently the number of blood-platelets may be again reduced below the normal level but recurrence of petechiæ is rare. A number of cases have been followed as long as five years after splenectomy without return of symptoms; on the other hand, there has been at least one case in which symptoms recurred about eighteen months after operation.

## HEMOPHILIA

The term hemophilia is applied to an inherited disease in which there is a tendency to profuse or even uncontrollable bleeding from trivial injuries. The subjects are popularly known as "bleeders."

The cause of the disease is unknown and there is no structural defect in the blood-vessels. The only alteration in the composition of the blood is a diminution in the number of blood-platelets. If the blood is tested when the subject is not in a hemorrhagic crisis the coagulation time will be found to be greatly prolonged.

The affection is strongly hereditary and its mode of transmission is characteristic. Only the male members of the stock suffer from the affection in its typical form, while the tendency is transmitted through the female line. An individual with hemophilia will transmit the tendency through his daughters to one-half their male children.

The disease is met with in otherwise healthy boys, and in 70 per cent of all cases the condition is noted before the fifth year. Very rarely the separation of the umbilical cord is followed by profuse hemorrhage. In general the first indication is long-continued and uncontrollable bleeding from some trivial wound or scratch. If a cut is made the hemorrhage from the larger vessels is easily arrested but capillary oozing persists. There may be apparently spontaneous hemorrhage from the gums, the nasal or intestinal mucous membranes. Subcutaneous or deeper effusions may occur without apparent cause. Hemorrhage into one of the larger joints is one of the commoner manifestations. There is variation in the tendency to bleed, it being greater at one time than another. Pulling a tooth and removal of the tonsils are particularly dangerous. After a severe hemorrhage the patient becomes anemic and there may be considerable elevation of temperature. In case of recovery the regeneration of the blood is rapid after bleeding ceases.

**Diagnosis.**—It is sometimes difficult to elicit the history of a family tendency to hemorrhage either on account of ignorance or of sensitiveness of the fact. Scurvy and purpura must be excluded. Recent hemorrhages into the cellular tissues may be confused with acute inflammatory conditions. Multiple ecchymoses aid in diagnosis.

**Prognosis.**—Prognosis is, in general, poor and the earlier in life the condition manifests itself the worse is the outlook. If middle age is reached the tendency to bleed appears to diminish. Many patients succumb sooner or later to hemorrhage although they often survive several severe attacks. It has been stated that over half of the cases die before the seventh year.

**Treatment.**—Locally innumerable measures have been tried. Prolonged pressure is probably the best single means of control. Application of normal blood has been advised. Thromboplastin may be applied. The use of ordinary astringents is of no avail. The intravenous or subcutaneous injection of 10 to 15 c.c. of serum, either human or animal, has proved useful. In case of emergency, diphtheria antitoxin may be used. Transfusion has a marked though often transient effect and is probably indicated at once in the event of hemorrhage. Periodic transfusions at regular intervals have been advocated as of value in lessening the tendency to bleed.

## HEMOLYTIC JAUNDICE

Hemolytic jaundice is a very uncommon disease and while it may not be familial it usually is. There are families in which jaundice has existed through several generations. It is transmitted through both males and females, not all of the children are affected and the descendants of unaffected members escape. It is due to increased blood destruction, the cause of which is unknown.

**Clinical Features.**—The jaundice may be noticed shortly after birth, or may develop at any time during childhood or later. The discoloration is rarely intense and may be so slight as to be noticeable only in the scleræ. It varies from time to time and may be increased after gastro-intestinal upsets. When once developed it never entirely disappears, as the jaundice is not obstructive but due to increased blood destruction. The stools contain bile and are usually darker than normal. There is an excess of urobilin in the urine but no bile. The spleen is regularly enlarged, often to an extreme degree. There may be attacks of biliary colic and perisplenitis. Gall-stones may be associated with the condition. The disease varies in severity but there is in certain cases surprisingly little disturbance of nutrition and life is not shortened. There is, however, a secondary anemia and the child with this condition is not as strong as he normally should be, and in the more severe cases is a semi-invalid. There are certain characteristics in the blood-picture which serve to distinguish this disease. Both the red cells and hemoglobin are reduced. Reticulated red cells, which are demonstrated by vital staining, are greatly increased. The increased fragility of the red cells is notable and practically diagnostic.

**Diagnosis.**—The diagnosis may usually be made if it is remembered that jaundice appears early, is usually hereditary, persists and is not obstructive. When in addition increased fragility of the red cells is found the diagnosis is positive.

**Treatment.**—Medical treatment is of little benefit and the only effective method is surgical. Splenectomy gives brilliant results which appear to be

permanent. This operation should be carried out in all but the mildest cases. The mortality is low unless the operation is done during an exacerbation of the disease.

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# CHAPTER X

## INCIDENCE OF TUMORS

It is impossible to give an accurate estimate of the incidence of tumors in childhood. We do know, however, that they are relatively infrequent as compared with adult life. Of the malignant growths, sarcoma is the usual type encountered in childhood and adolescence as is carcinoma in later life. It is true, however, that carcinoma, though rare at this period, may be met with at any age.

Many tumors result directly from anomalies of development and it is often impossible to draw a sharp line between malformation and tumor. Such mixed or teratomatous tumors, together with the rhabdomyomata and the tumors of the nervous system elements, occupy a distinct position. These tumors arise from remnants of undifferentiated tissue.

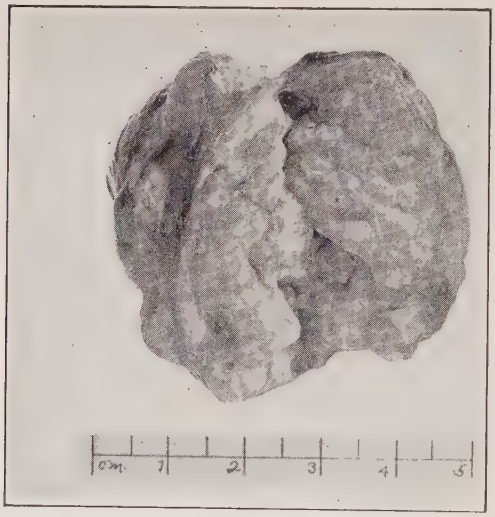


FIG. 18.—CONGENITAL TERATOMA OF THYROID GLAND, PRODUCING PARTIAL TRACHEAL OBSTRUCTION.

Operative removal when infant was two months old.

The distribution of tumors among the various organs during childhood is quite different from that in adult life. While no part of the body is exempt, certain regions are more prone to the development of new growths. The kidneys and adrenals are most frequently involved and furnish approximately 30 per cent of the malignant tumors observed in childhood. The eye and orbit, the bones, the brain and meninges are the next most frequent sites, each accounting for approximately 10 per cent of the total.

The diagnosis is frequently difficult on account of the lack of symptoms. The appearance of an unusual swelling is often the first sign. Disturbance of general nutrition is usually late, the child appearing to be in excellent general health until widespread metastasis has occurred when there is rapid

loss of weight and strength. The relatively frequent occurrence of a febrile reaction may suggest that the mass is of inflammatory origin.

All of the benign tumors which occur in adult life may be met with in

Fig. 19.—Fibroma in Axillary Region, Child of Two Years.

childhood. Tumors of blood- and lymph-vessels usually originate in early life and are of frequent occurrence and general distribution.

## HEMANGIOMATA

Hemangiomata may be divided according to the type of vessel composing them into capillary, venous and arterial.

Nevus is the term applied to a collection of dilated capillaries which may be cutaneous or mixed. The cutaneous nevus—"strawberry mark," "spider

Fig. 20.—Tumor of Neck and Axilla, Probably Sarcoma, Infant of Two Months.

Fig. 21.—Spindle-Cell Sarcoma in an Infant Thirteen Months Old.

Fig. 22.—Infected Hemangioma, Infant Ten Months Old.

nevus," "port-wine stain"—may occur on any part of the body, is frequent on the face and may be single or multiple. The size varies from the head of a pin to large areas and in color from light red to purple. Overgrowth of hair and skin may be associated and such a condition is spoken of as a nevoid mole.

Treatment is unsatisfactory save in the small ones, when desiccation with the electric needle may be tried. The extensive port-wine stains are best left alone, for while they may be eradicated the resulting scar is often even more objectionable.

Subcutaneous nevi are comparatively rare and while present at birth are often overlooked until later. The tumor is well defined, lobulated and

Fig. 23.—Multiple Hemangioma of Fingers, Boy Thirteen Years Old. (Case of J. J. Westermann.)

elastic. The size may be decreased by pressure but rapidly fills up again if the child struggles or cries. The skin covering it is normal or slightly bluish. It may be mistaken for a hernia, a meningocele or a spina bifida.

A mixed nevus is a subcutaneous nevus with more or less involvement of the skin and is the variety most frequently encountered. Such a tumor may occur anywhere but is usually met with on the head or face. It may also affect areas covered with mucous membrane. The lesion has the physi-

cal characteristics of a subcutaneous nevus but projects above the level of its surroundings. The skin over the whole extent or only a part may be invaded. Sometimes the margin only is red while the center has the appearance of a cicatrix.

Sometimes these nevi take on a rapid growth but they usually grow at about the same rate as the child. It is said that a considerable proportion

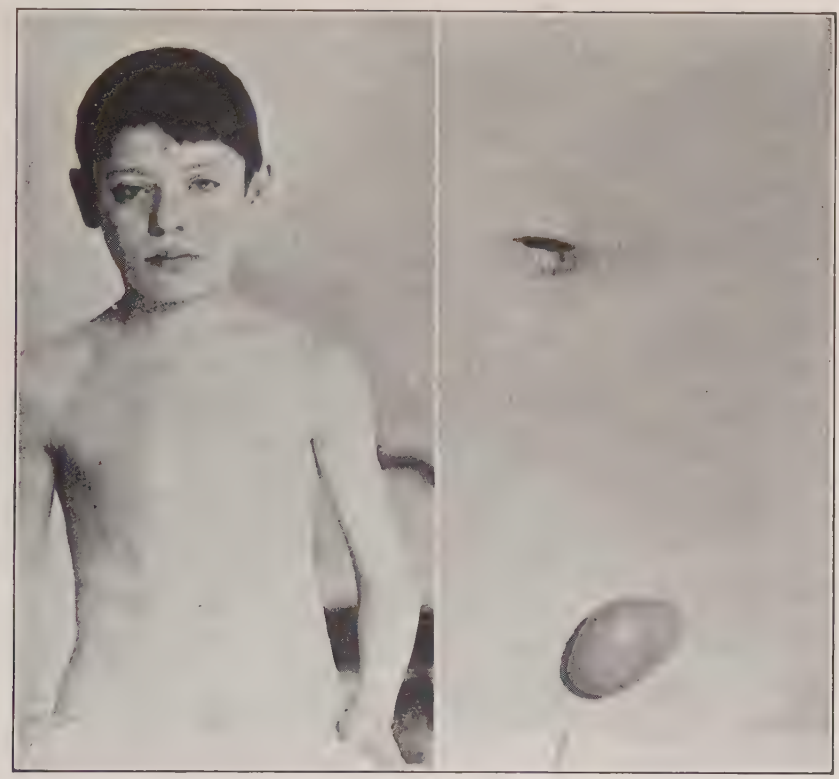

Fig. 24.—Localized Keloid in Hernial Wound.

undergo spontaneous cure by obliteration of the vessels. This has not been the experience of McLean and Cannon who in the case of circumscribed mixed nevi on the skin surface or mucous membrane advise treatment after the fourth month if the baby is in good general condition. They consider that, in general, carbon dioxid snow is the best method of removal but have also used radium. Where the tumor is situated near the anterior fontanel treatment should be deferred until the fontanel is closed. Where the nevus is situated at a mucocutaneous juncture, as the anus or vagina, and raised above the surface, carbon dioxid snow is the method of choice. In my opinion excision is to be preferred in subcutaneous nevi and in mixed nevi of moderate size situated on covered parts of the body.

A cavernous angioma usually results from progressive dilatation of the vessels in a subcutaneous nevus. Such a tumor is usually in the subcutaneous tissue but may occur in internal organs, especially the liver. When the tumor is accessible excision is indicated. Other methods of treatment are endothermy, radium and carbon dioxid snow.

Arterial angioma or cirsoid aneurysm has been referred to elsewhere.

## LYMPHANGIOMA

Lymphangioma is a swelling composed of a series of cavities filled with lymph and freely communicating with one another. There is only rarely a definite capsule and there is a great tendency to burrow into and

Fig. 25.—Lymphangioma of Region of Knee in Eighteen Months Infant.

about muscles and other neighboring structures. When the tumor is made up of a meshwork of cavities, somewhat like a sponge, it is called a cavernous lymphangioma. When it is composed of one or more large cysts it is called a cystic lymphangioma. The latter form may be derived from absorption of septa between the smaller cavities. All gradations between the two forms are met with and they may be associated, one part of a tumor being cystic while the remainder is cavernous.

**Cavernous Lymphangioma.**—This form appears as a defined swelling, varying from the consistence of a subcutaneous hemangioma to that of a solid tumor. Pressure will not decrease its size nor does crying or straining increase it. The diagnosis may be made definite by aspiration of lymph. The tumor may be confused with a lipoma or a subcutaneous nevus. In the discrete form, in an accessible location, excision is indicated. It is sometimes impossible to remove the more extensive tumors in

one stage, and more than one operation may be necessary. When operation is not possible radiotherapy is indicated and in the hands of some is said to be effectual.

**Cystic Lymphangioma (Lymphatic Cyst, Congenital Cystic Hygroma).**—This tumor is most often met with in the neck, though it may be

Fig. 26.—Lymphangioma of Axillary Region and Arm, Boy of Seven Years.

present in the axilla, groin or floor of the mouth where it may be confused with ranula. These swellings may attain a large size, are not tense. They are present at birth but may pass unnoticed. During the early months they may take on rapid growth and attain a large size. The walls of the cyst are thin and are so closely related to the surrounding tissues that it is often impossible to separate them. The actual extent varies greatly and the deeper portions have a great tendency to burrow and infiltrate among the fibers of the muscles and cellular planes of the neck. One explanation of their origin is that such a growth develops from an isolated collection of lymphatic tissue which has failed to establish connection with the general lymphatic system. Where the tumor is large and composed of large spaces there is a definite tendency to spontaneous cure. Operation should be deferred as the complete excision of such a tumor in infancy is not practicable. In the process of

Fig. 27.—Cavernous Lymphangioma in Pubic Region, Child of Ten Months.

growth the entire tumor, or that portion of it which is composed of large spaces, may spontaneously disappear, rendering an operation either unnecessary or of much less extent.

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# CHAPTER XI

## FRACTURES AND SEPARATIONS OF THE EPIPHYSES

### GENERAL CONSIDERATIONS

Such injuries form an important part of the surgery of childhood. Certain features peculiar to the bones of children have a bearing on the occurrence of certain types of fracture and on the result which may be

FIG. 28.—PARTIAL SEPARATION OF THE LOWER FEMORAL EPIPHYSIS IN A GIRL OF SEVEN YEARS.

Capacity for restitution of form in the period of active growth. The patient came under observation three weeks after injury, closed reduction was impossible and open reduction was not considered advisable.

expected from proper treatment. At this time of life the bones possess considerable elasticity and may be bent to a surprising degree without breaking. This explains the "greenstick fracture" in which the bone is bent and breaks only at the point of maximum convexity.

The periosteum is relatively thick and strong and strips easily, hence the frequency of subperiosteal fracture where the bone itself is broken

without rupturing the periosteum. In such instances there is relatively little displacement save by angulation at the point of fracture.

Fractured bones unite rapidly at this period of development and repair is usually complete. In the case of an infant a fracture is usually firmly united at the end of two to three weeks. In a child of five to six years a fracture of the forearm is united at the end of three weeks. Both bones of the leg may be expected to unite in four weeks and the femur in five to six weeks.

Fig. 29.—Same Case as in Figure 28, Seven Months Later.

Treatment consisted in immobilization for two weeks, followed by massage.

While non-union is not unknown in children its occurrence is very rare. Delayed union, however, is relatively frequent and commonly occurs in children who have rickets. The response to antirachitic measures is usually prompt.

The capacity for restitution of form in traumatic bone deformities in the period of active bone growth is remarkable and must be given due weight when the question of open reduction comes up. There is a tendency at times in infants to exuberant callus, giving rise to a bony tumor which may be mistaken for a new growth. This is particularly true in connection with fractures of the upper extremity of the humerus.

Dislocations are rare and if those of the elbow and thumb are excluded quite exceptional. The same trauma which in an adult produces dislocation in a child results in epiphyseal separation.

With the exception of the clavicle and the bones of the hands and feet a long bone has an epiphysis at each end. At birth the epiphyses are almost entirely cartilaginous with the exception of the two large bones forming

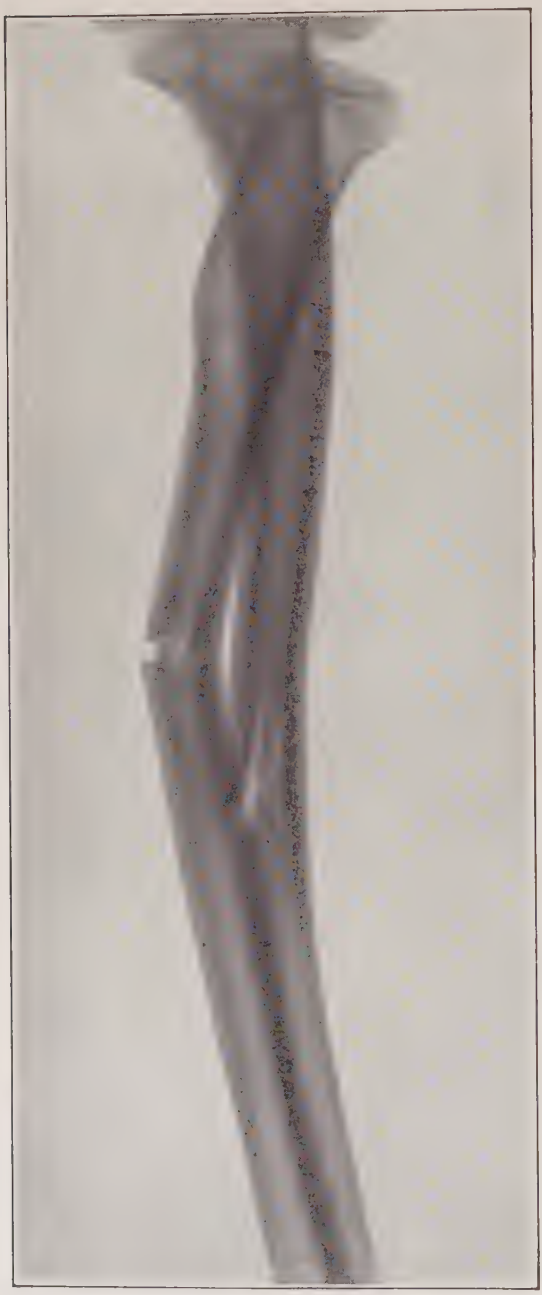


FIG. 30.—GREENSTICK FRACTURE, BOTH BONES OF FOREARM, IN A GIRL OF THIRTEEN YEARS.

the knee-joint. This block of cartilage (the epiphysis) is elastic and has little tendency to break. The zone of union between the cartilaginous epiphysis and the diaphysis or shaft, constitutes a weak point and traumatism may determine a separation. In older children there exists between the epiphysis, which is now ossified, and the diaphysis, a layer of cartilage known as the conjugal or epiphyseal cartilage. The increase in the length of the bone is almost entirely due to the activity of that part of the cartilage which is adjacent to the diaphysis. Between this cartilage and the diaphysis are three zones—the first is of normal cartilage, the second is of calcified cartilage and the third of temporary and brittle bone. It is through this third and brittle area that separation usually takes place. The epiphyses are supplied with blood from the periosteum, which accounts for the great rarity of necrosis even when the epiphysis is completely separated. In some separations the epiphyseal line may be followed exactly, in others bony fragments are detached. The condition may be observed at any period up to the time of complete union of the epiphysis with the diaphysis, but is most frequent between the ages of nine and seventeen. There may be all gradations from separation without displacement to complete separa-

tion. The complications of such injuries are varied and include wounds of the soft parts and injuries to vessels and nerves. The most important complication, however, has to do with the interference with growth due to a diminution of the ossifying power of the involved conjugal cartilage. Complete separation is not necessary as shortening may follow an injury where there has been no deformity. In comparison with the number of epiphyseal injuries interference with growth is rare, yet it is sufficiently frequent to make it necessary to always consider the possibility in injuries to growing ends of bone. On the other hand, injury to the shaft may stimulate the activity of the conjugal cartilage and the compensatory lengthening following fractures of the shaft may be attributed to this cause.

According to the period at which the injury is sustained fractures are classified as:

1. Intra-uterine
2. Obstetric
3. Injuries received after birth

**Intra-uterine Fractures.**—It is possible that such fractures only occur in subjects suffering from special congenital fragility of the bones. This condition is known as osteogenesis imperfecta and is strongly hereditary. If a child shows fractures at birth (unless sustained during delivery), it should be handled with care and kept on a pillow or Bradford frame for two years. No attempt to correct malunion should be made until the child is two or three years old. It has been recommended that calcium in some form, together with parathyroid extract be administered.

## BIRTH FRACTURES AND EPIPHYSEAL INJURIES [1]

In the majority of instances fracture or epiphyseal dislocation results from some form of operative or forcible delivery, usually breech extraction. Such fractures are rarely subperiosteal but usually complete and often associated with considerable displacement.

**Humerus.**—Fracture of the humerus is the injury most frequently met with. The fracture, which is usually transverse, is almost invariably situated at or near the center of the shaft. Often the obstetrician is aware of the injury when it occurs, if not, attention is soon attracted by the limp dangling arm, false point of motion, swelling and ecchymosis. Some degree of musculospiral paralysis is practically always present but requires no treatment as it clears up in a period varying from one to six weeks.

[1] Edward D. Truesdell has had an unexampled experience in these injuries which he has embodied in a valuable monograph, *Birth Fractures and Epiphyseal Dislocations*, Paul Hoeber, New York, 1917. I am indebted to this work for the material in this chapter.

Fig. 31.—Birth Fracture, Left Humerus.

Fig. 32.—Method of Treatment of Birth Fractures of the Humerus.

After applying a dusting powder to the axilla a square of folded gauze is placed beneath the arm and a swathe of adhesive plaster as broad as the distance from the point of the shoulder to the tip of the elbow is passed about the chest fixing the injured arm and forearm firmly to the chest wall. (Truesdell.)

FIG. 33.—METHOD OF TREATMENT OF BIRTH FRACTURES OF THE HUMERUS.

Over the adhesive plaster swathe is applied a Velpeau bandage of gauze. This in turn is secured by several narrow strips of adhesive plaster which serve materially to maintain the dressing. Roentgenograms made through the dressing will assist greatly in the proper application of this method of treatment. The arm is immobilized for three weeks. (Truesdell.)

*Treatment.*—Dusting powder and gauze protect the skin surfaces. The arm is applied to the chest wall after whatever manipulation is necessary to correct the deformity and the forearm is placed across the chest towards the shoulder of the uninjured side. A swathe of adhesive fixes the arm to the chest wall which acts as a splint. A Velpeau gauze bandage is then applied to hold the forearm in position. This bandage is removed every

FIG. 34.—BIRTH FRACTURE.

The Roentgen examination of a case first coming under observation on the thirteenth day showed a well marked external angular deformity with a well developed callous mass surrounding the point of fracture. Although union was quite firm an attempt was made to straighten the bone by manipulation of the arm and a smooth dressing then applied. (Truesdell.)

two or three days and the adhesive is changed twice in the three weeks during which the dressing is worn. External angular deformity noted in the course of treatment found in untreated cases may often be largely eliminated by manipulation up to the end of the second week. The presence of deformity after union is not so important as in the case of fracture of the femur. Union invariably occurs and nature's ability to accomplish elimination of deformity in the process of growth is remarkable.

**Clavicle.**—Fracture of the clavicle is the next most frequent injury. The fracture, which is complete in most instances, is usually at the center

of the bone. The disturbance may be so slight that the injury escapes notice until the swelling due to callus directs attention to it.

*Treatment.*—Where the fracture is single a Velpeau bandage is applied. When both clavicles are broken a figure of eight bandage is used. The results are good.

Fig. 35.—Birth Fracture.

Picture taken through the dressing immediately after this procedure showed a very definite improvement in the fractured humerus. (Truesdell.)

**Femur.**—Fracture of the femur, while less frequent, is the most important of the birth fractures for the reason that deformities uncorrected in the early treatment have been found to persist long after deformities of corresponding degree have disappeared in cases of birth fracture of the humerus. This injury is also usually incidental to breech delivery. The site of fracture is at, or just above, the middle of the bone. The line of fracture is usually transverse and there is a marked tendency to displacement, the most important feature of which is an anterior angulation with a tendency to overriding.

FIG. 36.—BIRTH FRACTURE, LEFT FEMUR.

*Treatment.*—The two most satisfactory methods of treatment are by Truesdell's box splint and the Van Arsdale splint. With the former there is an opportunity for traction to counteract overriding. It is, however, more important to maintain proper alignment than to counteract overriding. Whatever method is chosen, frequent changing is necessary. The treatment is difficult and failure to correct anterior angulation will result invariably in an anterior curvature of the femur persistent throughout childhood but which apparently does not result in disability.

**Epiphyses.**—Dislocation of the cartilaginous epiphyses may occur when during labor, and usually in breech extraction, force is brought to bear on the

Fig. 37.—Same Patient as in Figure 36 at Four Weeks.

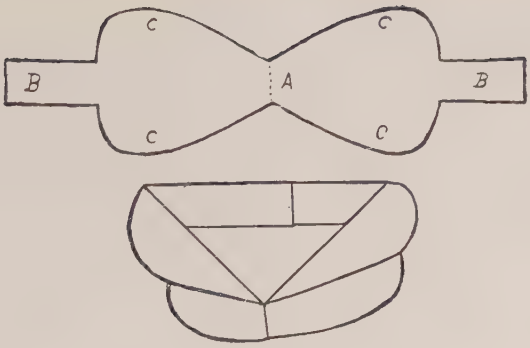



FIG. 38.—VAN ARSDALE SPLINT.

Cut from thin sheet metal, preferably aluminum as outlined in the upper figure, bent at a right angle at *A* and secured in this position by bringing the prolongations *B* together. The wings *C* are then bent over to form the sides of the splint. The edges are protected with adhesive plaster and the splint is padded with felt and applied with roller bandages reënforced with strips of adhesive. In certain fractures when the site is in the upper third of the femur it is desirable that the angle formed by bending the splint at *A* be less than a right angle. (Truesdell.)

FIG. 39.—VAN ARSDALE SPLINT APPLIED. (Truesdell.)

ends of the long bones. The epiphyses of the humerus and femur are most frequently affected. After delivery there is failure to use an extremity and ordinary fracture is eliminated by the lack of a false point of motion

FIG. 40.—UNTREATED BIRTH FRACTURE OF THE FEMUR SEEN FOR THE FIRST TIME AT FOUR WEEKS.
A lateral view at the tenth week discloses an excessive anterior angulation. (Truesdell.)

at the center of the bone. A swelling occurs shortly and in the second week a roentgenogram will show the new bone formed under the stripped up periosteum. Even when displacement is marked the outcome is good as there is a marked tendency for the deformity to be eliminated in the process of growth.

FIG. 41.—SAME PATIENT AS IN FIGURE 40, A LATERAL VIEW AT THE TWENTIETH MONTH.

The anterior curvature characteristic of these fractures when the original anterior angulation has remained uncorrected persists. The child was walking perfectly, there was no disability of any sort while the measurements of the legs were equal. (Truesdell.)

Fig. 42.—Birth Dislocation of the Lower Humeral Epiphysis.
At the fourth week the Roentgen picture characteristic of the injury was obtained. (Truesdell.)

Fig. 43.—Birth Dislocation of the Upper Humeral Epiphysis.

## INJURIES RECEIVED AFTER BIRTH

### Fractures

During the early period of childhood, fractures occur infrequently and usually as a result of a fall. The clavicle and femur are the bones most frequently involved. It is often difficult to get a history of the accident either because it was not noticed or because the mother or nurse is unwilling to acknowledge the fact of the fall. In the beginning the only symptom is the unwillingness of the child to use the injured member. This is quickly noted when the child is watched. At the end of ten days an obvious enlargement at the site of the injury, due to rapid growth of callus, is noted. This tender swelling may first call attention to the fact that there has been an injury. After walking is established the incidence increases progressively to early adult life. After six years they are much more frequent in boys than in girls.

**Signs of Fracture.**—The signs of fracture are:

1. Evidence of local injury, swelling and later ecchymosis
2. Localized bony tenderness—a very important sign in the absence of deformity
3. Deformity which may be merely angulation or may be lateral displacement with more or less overlapping resulting in shortening. Either fragment may possess an abnormal rotation.
4. Abnormal mobility
5. Crepitus which is most easily and safely elicited by very gentle manipulation
6. Impaired function

**Diagnosis.**—One cannot expect to find all these signs in every case. The history of injury and localized bony tenderness warrant a tentative diagnosis of fracture. The possibility of associated nerve injury must always be considered. Roentgenograms, always in two planes, should be made in every suspected case. The investigation should begin with careful examination of the corresponding sound member.

**Principles of Treatment.**—1. Reduction of the deformity under anesthesia at the earliest possible moment. A fracture should be regarded as an emergency and so treated. Not only is the reduction facilitated but injury to the soft parts is greatly lessened and convalescence shortened.

2. Maintenance of reduction until union has occurred, thereafter prevention of weight-bearing until union is complete. Reduction is always verified by means of a roentgenogram.

3. Careful regard for the nutrition of the surrounding muscles and the mobility of the adjacent joints.

4. Due attention to the care of the skin, frequent washing and the free use of dusting powder-talcum or equal parts of starch and zinc oxid.

5. Consideration of and appropriate treatment for any associated general condition such as rickets.

In some fractures, of course, there is no deformity or it is so slight that it may be corrected without recourse to anesthesia. In the more complicated fractures it is a great advantage to be able to reduce the displacement under direct vision with the aid of a fluoroscope. Open operation is called for in fractures of the olecranon and patella and in certain injuries about the joints, notably the elbow, where the displaced fragment would materially interfere with function. Since the use of skeletal traction has become general the need for open reduction, in fractures of the long bones in children, has practically disappeared. The exceptions are certain fractures of both bones of the forearm and any fracture where interposition of the soft parts prevents reduction. This last condition is extremely rare where adequate traction has been maintained. In fresh fractures every effort must be directed toward securing adequate reduction, but when union has occurred, even in extremely bad position, due weight must be given to the remarkable power that the growing bone has to correct deformity. It may be at times necessary to consider the question of operation under uncertain aseptic conditions. An infected bone is immeasurably worse than a deformed bone. Operations on bone should only be undertaken by experienced surgeons under adequate aseptic conditions.

**Clavicle.**—About one-third of all fractures of the clavicle occur in children under five years of age. A slight injury is the usual cause and the fracture is frequently incomplete. In infants the fracture may not be recognized until a tender, hard tumor, attached to the bone, makes itself evident. Disinclination to use the arm is often the only symptom. In young children even where the fracture is complete displacement is usually relatively slight.

*Treatment.*—Where the fracture is incomplete and where there is little or no displacement it is only necessary to restrain the movements of the arm for twelve to fourteen days. This is best accomplished by means of a swathe or bandage holding the arm to the side and with the wrist supported by means of a sling. The dressing should be removed every third day and replaced after the skin has been bathed and powdered. In infants it is often only necessary to pin the arm of the shirt to the body of the shirt. When reduction is necessary it should be accomplished under an anesthetic. When the fracture is complete the characteristic deformity is present, the

outer fragment falling forward, downward and inward. Therefore, to maintain reduction, the outer fragment and with it the shoulder must be lifted backward, upward and outward. I am not familiar with any thor-

FIG. 44.—FRACTURE OF THE LEFT CLAVICLE IN AN INFANT OF TWENTY MONTHS.

oughly satisfactory method of maintaining reduction. The figure of eight bandage, passing around each axilla and crossing between the scapulæ, is sometimes efficacious. There should be a pad of cotton in the mid-scapular region and in the fold of the axilla. The modified Sayre dressing

is probably the most popular form of treatment. Where there is gross deformity it should be reduced and reduction maintained by a plaster figure of eight bandage applied under anesthesia.

*Prognosis.*—Prognosis in children is good as to function and union. There is frequently, however, some deformity at the site of the fracture which usually becomes progressively less as the years pass. The width of the shoulder may be shortened and not infrequently there is a temporary slight lateral deformity of the spinal column. However, the residual deformity is rarely noticeable.

**Scapula.**—Fractures of the spine or body of the scapula may occur. The diagnosis is difficult as there is usually much swelling and hematoma. Tenderness and hematoma limited to the shoulder blade are suspicious. A roentgenogram will clear up the matter.

*Treatment.*—Confine the arm to the side with a swathe or bandage and support the forearm with a sling.

**Humerus.**—Injuries to the upper end of the humerus comprise:

1. Fracture of the surgical neck
2. Separation of the upper humeral epiphysis
3. Fracture of the greater tuberosity

Surgical Neck.—Any fracture within the upper fourth of the bone and below the epiphyseal line may be regarded as a fracture of the surgical neck. Such a fracture may result from a fall on the outstretched hand, or, more rarely, from direct violence. The line of fracture is usually transverse, may be subperiosteal without displacement, and even when the periosteum is ruptured there is less tendency to gross displacement at this time of life. When there is displacement the almost constant tendency is toward abduction and outward rotation of the upper fragment, adduction and forward and upward displacement of the end of the shaft.

*Clinical Features.*—The clinical features are signs of local damage, voluntary fixation and pain. The head of the bone is in the glenoid and moves with the shaft in impacted fractures. In others there is abnormal mobility and crepitus. Measurement from the tip of the acromion to the external epicondyle reveals shortening if there is overriding.

Upper Humeral Epiphysis.—The three centers of ossification, the two tuberosities and the head, coalesce to form the upper humeral epiphysis. Separation may occur from the time of birth up to twenty-five years but is most frequent between nine and seventeen. It is usually the result of a severe wrenching trauma. The lesion is a clean separation in early years, while later there is frequently a chip of the diaphysis attached.

FIG. 45.—FRACTURE OF THE SURGICAL NECK OF THE HUMERUS IN A GIRL SIX YEARS OLD.

*Clinical Features.*—The displacement is almost always in the same direction as in fracture of the surgical neck and the upper extremity of the diaphysis is carried upward, forward and inward. The anterior edge of the upper end of the shaft may be felt at the point of the shoulder below

the acromion. Dislocation, for which this injury has frequently been mistaken, may be ruled out by palpating the head of the humerus in the glenoid. Where there is no displacement injury to the epiphysis may be suspected when there is localized tenderness.

Greater Tuberosity of Humerus.—Fracture of the greater tuberosity is very uncommon in children but may be suspected where there is limitation of movement with tenderness over the tuberosity without deformity.

The exact type of injury is often revealed only by a roentgenogram.

*Treatment.*—Where there is displacement demanding reduction anesthesia should always be administered and reduction accomplished by manipulation, traction and countertraction. It is in the separation of the epiphysis that the greatest difficulty is met and the obstacle to reduction is the interposition of the torn and stripped up tube of periosteum. If closed reduction is impossible, open operation is indicated. After reduction a triangular pad is placed with apex in the axilla, the base being 2 to 3 inches thick and the pad somewhat thinner anteriorly than posteriorly. The arm is bandaged to the chest, the elbow flexed and the wrist supported with a cravat sling. It is important not to support the elbow as the slight traction by the weight of the arm is of advantage. Reduction should be confirmed by means of a roentgenogram. The dressing should be inspected daily and removed and replaced every three or four days. Gentle massage may be begun at the end of seven to ten days and union should be firm at the end of three weeks.

*Results.*—If reduction has been good the result should be excellent. In separation of the epiphysis, even when there has been no displacement, there may be some shortening.

Shaft of Humerus.—The fracture is often oblique or spiral and the usual site about the middle. The possibility of injury to the musculospiral nerve must always be considered.

*Treatment.*—If there is displacement reduction should be attempted under anesthesia. In transverse fractures which have been successfully reduced, and in those with little displacement, it is sufficient to apply coaptation splints about the arm. These may be made by facing soft splint wood with adhesive and then scoring the wood with vertical cuts one-quarter inch apart. A pad such as was previously described is placed in the axilla, care being taken to have it long enough to support the internal condyle. The arm is fixed to the body by means of an adhesive swathe, the wrist is supported with a cravat sling and particular care is taken not to support the elbow. If there is a tendency to recurrence of the displacement and particularly if the line of fracture is oblique, traction should be maintained through lateral moleskin straps. Probably the best method of applying ambulatory traction is by means of the Jones humerus traction splint.

*Result.*—Union almost invariably occurs and with the exception of those cases complicated by injury to the musculospiral nerve the progress is uniformly good.

**Elbow.**—The fractures that occur in this region are transverse fractures above the condyles and oblique fractures through the condyles. These last may involve only the epicondyles and be extra-articular or they may involve the trochlea or capitellum. A T- or Y-shaped fracture may detach both condyles. There may be a fracture of the olecranon and of the neck of the radius. Posterior dislocation of the elbow is one of the few dislocations which are met with in children.

Fig. 46.—Supracondylar Fracture with Slight Displacement in a Boy Thirteen Years Old.

The lower humeral epiphysis is made of three centers—external epicondyle, capitellum and trochlea which unite with each other about the thirteenth year. The epiphysis of the internal condyle is separate and unites with the shaft about the eighteenth year. Separation of the entire lower epiphysis may occur at any age until the epiphyseal line disappears at about the fifteenth to seventeenth year but is rare after thirteen years. The complexity of the development of this epiphysis adds a number of epiphyseal separations, but the symptoms and clinical course resemble so closely the corresponding fractures that it is not desirable to consider them apart.

*Method of Examination.*—The first step in the examination is the determination of the relation of the bony landmarks, using the uninjured

elbow for comparison. This is conveniently done by placing the tips of the thumb and middle finger on the two condyles and that of the index finger on the olecranon and noting their relation in flexion at a right angle and in extension. When the elbow is extended, the two condyles are on a line and the tip of the olecranon is just slightly above this line. In flexion to a right angle the three landmarks form a triangle with the olecranon tip as an apex. The head of the radius is felt about one-half inch below

FIG. 47.—TRANSVERSE FRACTURE OF THE LOWER EXTREMITY OF THE HUMERUS ABOVE THE CONDYLES IN A GIRL OF SEVEN YEARS.

Lower fragment displaced forward.

the external epicondyle. When the elbow is extended it may be noted that the forearm deviates from the body, forming what is known as the "carrying angle." The carrying angle is about 170° and is distributed equally between the arm and the forearm, so that when the elbow is hyperflexed the forearm is superimposed on the humerus. Therefore, if the forearm be brought up so that its axis coincides with that of the humerus the carrying angle will be maintained.

A careful and thorough examination should be made of every injured elbow. To put a wet dressing on a swollen elbow and wait for the swell-

ing to subside before the existence of a fracture is known paves the way for many difficulties. The patient's clothes should be removed to the waist and the normal elbow examined first. Then the position in which the injured member is held is noted, as well as the presence of abrasions and the localization of any swelling. The amount of active motion of the joint is ascertained. In examining the injured elbow locate the subcutaneous border of the ulna and follow it up to the olecranon. Then follow the radius up to

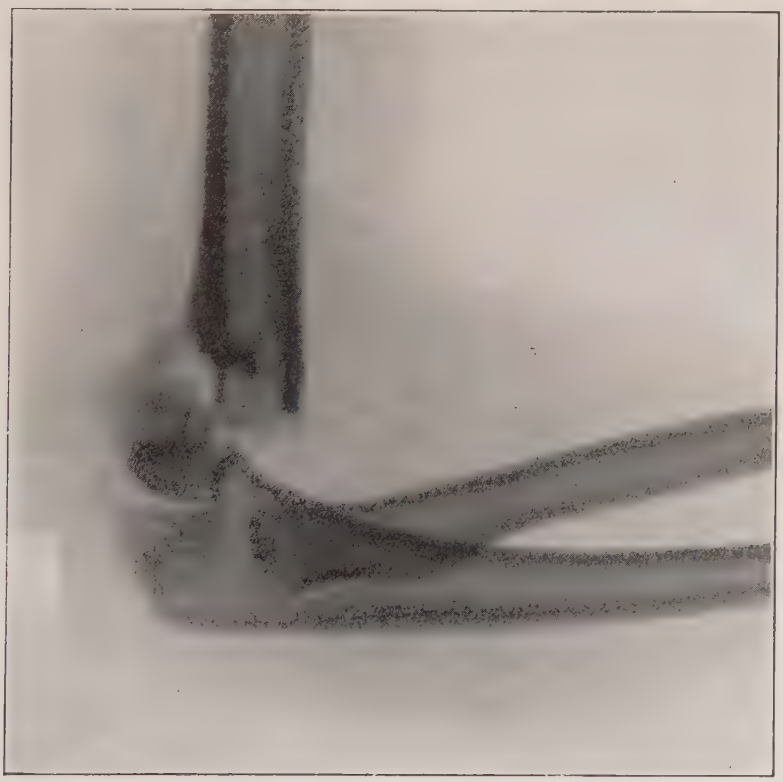


FIG. 48.—TRANSVERSE FRACTURE OF THE LOWER EXTREMITY OF THE HUMERUS IN A BOY OF SEVEN YEARS.

Lower fragment displaced backward.

its head after locating the internal condyle. Above the radial head the external condyle may be easily found. When these landmarks have been identified, their relation to each other is noted. If this relation is normal there is no dislocation but there may be a fracture. If the relation is abnormal there may be one or the other and rarely both. The shaft of the humerus is now followed down as far as possible. Finally the ulna and median nerve distribution is tested for disturbances of sensation and the musculospiral distribution for motion. Subsequently, by motions of

FIG. 49.—SUPRACONDYLAR FRACTURE IN A BOY SIX YEARS OLD.
Complete lateral displacement.

flexion and extension, grasping the condyles in either hand, crepitus may be elicited and abnormal lateral mobility at the elbow demonstrated. It is frequently impossible to make a satisfactory examination without anesthesia. Diagnosis must always be confirmed by roentgenograms.

*Clinical Features.*—Supracondylar fractures and fractures of the external condyle are the most frequent. In the former the deformity resembles, somewhat, a posterior dislocation of the elbow. There is a projection forward of the lower end of the upper fragment; posteriorly put the point of the elbow is abnormally prominent but the bony landmarks are in normal relation. A supracondylar fracture may exist with little deformity. In fractures of the external condyle there is localized swelling and loss of the carrying angle. The epicondyle is displaced downward and forward. Fracture of the internal epicondyle in young children is really more in the nature of an epiphyseal separation. Little serious disability follows the injury. Localized swelling and ecchymosis may be noted, the loose fragments detected and crepitus elicited. In separation of the lower humeral epiphysis there is less tendency to deformity than in the supracondylar fracture, and it may be taken for a severe sprain. There is, however, severe pain, localized tenderness and soft crepitus. When the line of separation passes entirely through cartilage it will not be visible in roentgenograms and the diagnosis must be made from clinical symptoms.

FIG. 50.—DISPLACEMENT OF THE CAPITELLUM IN A BOY OF SEVEN YEARS.

In fracture of the internal condyle there is usually considerable swelling and loss of the carrying angle. T- and Y-shaped fractures are very rare in children and are the result of so severe an injury that there may be compounding. The width of the elbow is increased and the joint cavity may be distended with blood.

While dislocations may occur in other directions the overwhelming majority are backward. The great prominence of the olecranon and the abnormal relation of the three landmarks generally serve to make a diagnosis.

The chief complications are nerve injuries. An interesting form is the ulnar paralysis appearing many years after fracture of the external condyle.

*Treatment.*—Reduction should be accomplished under anesthesia. In supracondylar fractures, after hyperextension and traction in the long line of the axis of the limb, forced flexion brings the elbow into the position of hyperflexion. In fracture of the external condyle the carrying angle must be restored by abduction and reduction maintained by hyperflexion. In the other fractures of the lower extremity of the humerus the position of hyperflexion is usually the best method of maintaining reduction. In this position the coronoid process anteriorly, the fascia posteriorly and laterally and the triceps posteriorly serve as natural splints. The elbow is maintained in a position of hyperflexion, the forearm being so directed as to lie in exactly the same plane as the humerus. The flexure of the elbow is protected with a piece of gauze and after several circular turns of a two inch muslin or flannel bandage about the wrist the bandage is carried around the upper arm as close to the axilla as possible. The bandage passes from the outer to the inner edge of the dorsal surface of the forearm and is then continued, finally covering the elbow by means of figure of eight turns. The wrist is fastened by the remainder of the bandage to the neck. The dressing should be inspected within twenty-four hours and the parents warned to notify the physician of swelling or blueness of the fingers. Three days later the bandage is removed, the arm and forearm washed, particularly the flexure, and the dressing replaced. Thereafter the dressing is replaced every third day. At the end of two weeks the degree of flexion is lessened and the angle is gradually increased until at the end of four weeks the forearm is in a sling with the elbow at right angles. In fractures at the elbow it is not desirable to enforce passive movements. After four weeks the patient is encouraged to use the elbow, carry weights and exercise in climbing and gymnastics. Occasionally, particularly when the arm is seen late, the swelling is so great that hyperflexion cannot be at once attained. Put the arm in as much flexion as possible and increase as the swelling goes down. When a fragment, usually an epiphysis, is completely displaced and attempts at closed reduction have failed, open reduction is indicated and the most favorable time is five to seven days after the injury. Posterior dislocation may be reduced by complete extension of the forearm, downward traction on the forearm with countertraction on the arm, followed by flexion. An alternative method is by grasping the lower humerus in both hands and thrusting forward and downward on the olecranon with

the two thumbs. Fracture of the olecranon in young children should be treated with the elbow in extension and a pad fastened with adhesive over the displaced fragment. In older children when displacement is marked the fragment should be sutured in place. In fracture of the neck of the radius the elbow should be dressed at a right angle with the forearm supinated.

*Results.*—If diagnosis is made early and treatment instituted, the prognosis is usually good. With accurate reduction there is little tendency to exuberant callus and a good range of motion is obtained. Where reduction is not accurate there may be some limitation of motion with loss of the carrying angle.

Fracture should be suspected in every injury about the elbow and examination supplemented by roentgenograms. With adequate reduction under anesthesia and the use of the hyperflexed position bad results are the exception. In the T- or Y-shaped fracture the right angle splint is preferable. When the immediate result is bad the condition may improve as growth takes place.

Isolated dislocation of the head of the radius is not very infrequent in children. Dislocation backward is very rare. In dislocation outward the head of the radius projects on the other side of the elbow. Dislocation forward is most frequent and may be complete or incomplete. In the former it is the result of a fall or of direct traction on the forearm. There is an abnormal projection just below the capitellum and on pronation and supination this is found to be connected with the radius. On the posterior surface of the joint there is a depression which corresponds to the normal situation of the head of the radius. Flexion is limited. There is difficulty not only in reduction but also in maintaining the position after reduction has been accomplished. In recent cases it may be necessary to resort to open operation. In old cases resection of the radial head may be necessary but this should be deferred until after the eighteenth year.

*Pulled Elbow.*—The incomplete dislocation of the head of the radius is peculiar to children, is most frequent in the second and third year and is not seen after the eighth year.

It practically always results from traction on the forearm, the child having been lifted or dragged by the wrist. From the way in which the injury is produced the wrist is also often swollen and in some cases the patient is brought to the surgeon on account of this swelling. The child cries out and probably stops using its arm. The arm hangs at the side with the elbow slightly flexed and the forearm pronated. There is no swelling. On palpation over the elbow there may be slight crepitus. The pathology is in doubt but the condition is probably due to a special laxity of the annular ligament which permits partial dislocation of the head of the bone.

Recurrence is not uncommon. Reduction is accomplished by supinating the forearm and pressing backward on the head of the radius. The elbow should be immobilized for forty-eight hours save in recurrent cases where immobilization should last for two weeks.

**Ulna.**—Isolated fracture of the ulna, particularly if the break involves the upper portion of the shaft, is not infrequently associated with anterior luxation of the head of the radius. The importance of the combined injury lies in the fact that while the fracture of the ulna is usually recognized, the *dislocation of the radial head* is frequently overlooked. If the dislocation is overlooked, the fracture will probably unite with such deformity as to interfere with subsequent treatment. On the other hand, if the dislocation is recognized and reduced, the ulnar fracture will usually unite in good position.

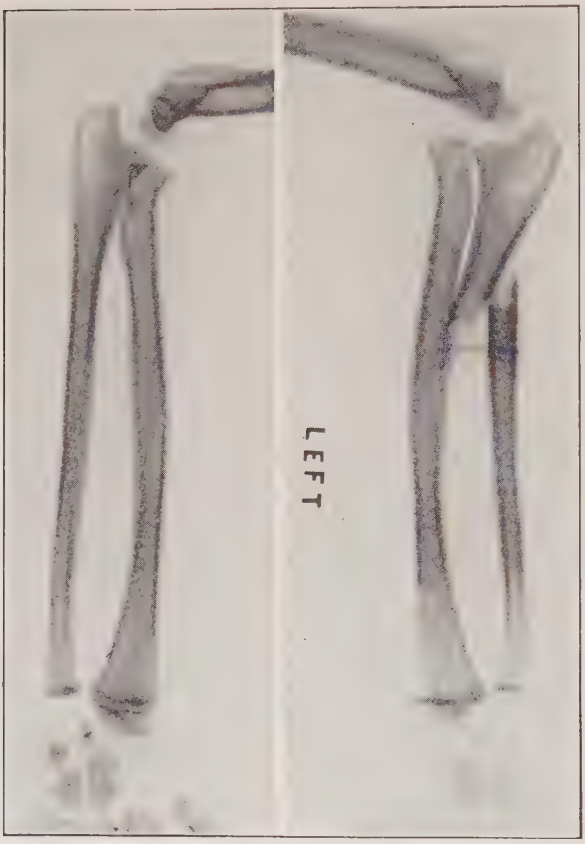



FIG. 51.—FRACTURE OF THE SHAFT OF THE ULNA COMPLICATED BY DISLOCATION OF THE HEAD OF THE RADIUS IN A BOY OF SIX YEARS.

The normal elbow for comparison.

Therefore, in every isolated fracture of the shaft of the ulna the possibility of associated dislocation of the head of the radius should be considered. Conversely, in every dislocation of the head of the radius, fracture of the shaft of the ulna should be sought for.

*Diagnosis.*—The diagnosis of the fracture is based on mobility and crepitus, and may usually be made on manipulation. The dislocation forward of the radius limits flexion at the elbow to about a right angle, from contact of the radial head with the humerus above the condyle. The radial head may be made out above its normal position. Injury to the musculospiral nerve may result in more or less paralysis of the extensor muscles of the wrist and fingers.

*Treatment.*—If possible, secure reduction by manipulation alone, avoiding injury to the musculospiral nerve by too strong pressure on the radial head and by hyperextension of the elbow. After reduction the elbow should be dressed in hyperflexion. If closed reduction is impossible, arthrotomy should be resorted to, suturing the torn capsule around the neck of the radius.

In old cases an attempt at reduction by arthrotomy should be made. When there is non-union in the ulnar fracture this should first be exposed and the fragments freed. When reduction of the dislocation is impossible, it is unwise to resect the head of the radius before the eighteenth year because of the resulting interference with the growth of the bone.

Function is sometimes surprisingly good, even in the presence of an unreduced dislocation and malunion of the ulna.

Fig. 52.—Fracture of Both Bones of the Forearm with Slight Displacement in a Boy of Five Years.

**Both Bones of Forearm.**—Fractures of the bones of the forearm are very frequent in children. The classical Colles's fracture, so frequent in adults, is almost unknown in early life, its place being taken either by separation of the lower radial epiphysis or by fracture of both bones some distance above the wrist. The displacement in such cases is not unlike that of the typical Colles's fracture but the angle is higher up in the forearm. Toward the middle of the shaft the displacement is quite different. Here there is usually seen an exaggeration of the normal curve of the forearm, that is, a curve with the convexity backward. Frequently the fracture is incomplete or greenstick in one or both bones. There may be an isolated fracture of the shaft of either the radius or the ulna, often the result of

FIG. 53.—FRACTURE OF BOTH BONES OF THE FOREARM IN A FIFTEEN MONTHS INFANT.

direct violence. If the fracture occurs in the upper third of the radius there may be considerable displacement of the proximal fragment. If in the lower third the lateral deformity may suggest that of a Colles's fracture, the hand being displaced to the radial side with prominence of the head of the

ulna. When the injury involves the ulna the displacement is, as a rule, slight, the radius acting as a natural splint.

*Diagnosis.*—The diagnosis may usually be made even in the absence of displacement by localized bony tenderness, easily elicited on account of the superficial situation of the bone.

Fig. 54.—Fracture of Both Bones of the Forearm in a Boy of Eight Years.

*Treatment.*—Where there is displacement reduction should be accomplished under anesthesia and in the case of greenstick fractures there should be slight overcorrection. Where there is overriding and angular deformity an assistant makes countertraction upon the upper forearm while the surgeon

makes traction on the lower end at the same time pressing the bones into shape. Reduction may be maintained in several ways but whatever method is chosen the joints above and below the fracture must be fixed. Molded

Fig. 55.—Fracture of Both Bones of the Forearm in a Boy of Ten Years.

plaster palmar and dorsal splints or a circular plaster bandage applied over one layer of sheet wadding from the axilla to the metacarpophalangeal joints may be used. Lateral compression should be avoided. The forearm should be in a position midway between pronation and supination with the thumb up. If a circular plaster case has been applied it is a wise pre-

FIG. 56.—FRACTURE OF BOTH BONES OF THE FOREARM IN A GIRL OF THIRTEEN YEARS.

caution to split it through its whole length after the plaster has hardened. The patient should be seen daily. If the splint becomes loose a strip may be removed reducing the circumference and the splint reapplied after protecting the edges with adhesive.

Palmar and dorsal splints of wood may be used. The splints should be one-quarter inch wider than the forearm, the dorsal extending from just below the elbow to the metacarpophalangeal joint, the palmar to the middle of the hand. Both should be carefully padded, the palmar with particular

Fig. 57.—Fracture of Both Bones of the Forearm above the Wrist Joint in a Girl of Five Years.

reference to the irregularities of the palmar surface of the forearm. These two splints are steadied by means of adhesive straps, care being used so that they are not too tight. They should buckle on slight pressure together of the splints. Pressure should never be exerted through unyielding adhesive but wherever it is necessary should be obtained through bandaging. The elbow is immobilized by an internal right-angled splint. Any complaint of

pain should receive consideration and the treatment should be checked by frequent inspection and occasional roentgenograms. It is embarrassing to take down a dressing after several weeks and find the bones healed in a position of exaggerated deformity. In certain instances it is desirable to dress the forearm in a position of supination. The Sinclair splint is particularly adapted for this purpose.

Fig. 58.—Separation of the Lower Radial Epiphysis in a Boy of Thirteen Years.

Fracture of both bones in the lower third and separation of the lower radial epiphysis may be treated alike. Reduction is accomplished under anesthesia and is usually easy in epiphyseal separation. Where there is a fracture the hand is supinated, the lower fragment is freed from the upper by pressure and hyperextension and the lower fragment is forced into position by direct pressure. Reduction is maintained by palmar and dorsal molded plaster or wooden splints extending from above the mid-forearm to the heads of the metacarpal bones. A cutout should be made for the ulna

head and the forearm is carried in a sling with the thumb up. The anterior splint is left off after the first week.

In epiphyseal separation where reduction has been satisfactory it is only necessary to retain the splints for from seven to ten days. In all recent fractures of the forearm where there is gross displacement which cannot be corrected open reduction should receive careful consideration. In fractures of both bones the radius is the more important in reduction. When union has occurred even in bad position it is probably best to wait and see what time will do toward correcting the deformity.

Fig. 59.—Fracture of the Lower Extremity of the Radius with Separation of the Lower Ulnar Epiphysis in a Girl of Ten Years.

Fig. 60.—Same Case as in Figure 59 after Reduction.

**Metacarpal Bones.**—Fractures usually result from direct violence. Reduction is accomplished by traction on the corresponding finger and local pressure. Position is maintained by a palmar splint and a soft rubber tube

about one-half inch in diameter on either side of the fractured bone dorsally. When there is a persistent tendency to recurrence of displacement elastic traction, maintained through the corresponding finger, is often effective.

Fractures of the phalanges are best treated after reduction by a palmar splint including the finger on either side of the injured one. Contact between the skin surfaces should be prevented by means of powder and gauze.

Fig. 61.—Fracture of the Pelvis, Boy Ten Years Old.
Note ecchymosis of scrotum.

**Neck and Epiphysis of Femur.**—Fracture of the neck of the femur is not frequent in children but is not so uncommon an injury as is generally supposed. The fracture is usually greenstick or impacted when complete and the clinical picture differs greatly from that in a similar injury in old age. The injury usually results from a fall directly on the hip. There is moderate shortening (one-half to three-quarters of an inch) on measurement from the anterior superior spine to the tip of the internal malleolus,

some eversion, and motion is restricted. Discomfort is slight and after a short while the child may apparently recover and walk about with only a slight limp. Later signs of coxa vara may appear. This differs markedly from the complete disability resulting from a trivial injury in the aged. The fact that the diagnosis is frequently overlooked and the child treated simply for a contusion or sprain makes it important to have a roentgenogram in all hip injuries. When diagnosis has been made the deformity should be corrected and the limb put up in wide abduction according to the Whitman method by means of a plaster spica extending from axilla to toes with the thigh abducted, extended and internally rotated. This position should be maintained for from ten to twelve weeks after which a walking caliper is

A B

Fig. 62.—*A*. Separation of the Upper Femoral Epiphysis in a Boy of Fifteen. *B*. Same Case after Reduction.

provided. The late results in untreated cases resemble hip disease. Diagnosis may be made by history and roentgenogram. If the disability is increasing operation should be considered. Epiphyseal fracture or separation usually occurs in adolescents. While it may be complete as a result of severe violence it is usually incomplete. As a result of injury there is a gradual displacement of the head upon the neck and unless the deformity is checked in the process of repair there may be complete disjunction. After an injury sometimes so slight as to be disregarded the patient begins to limp and complains of discomfort in the hip and the diagnosis of hip disease may be made. Whereas in hip disease motion is checked in almost equal degree in all directions, in this condition extension is increased in range. The roentgenogram is distinctive. In the cases where there is complete separation the condition is usually readily recognized. Treatment is as indicated in fracture of the neck of the femur. When the progression

Fig. 63.—Fracture of Femur in Infant Five Months Old.

Van Arsdale splint in position. In spite of overriding the alignment is fair which is the essential detail.

Fig. 64.—Fracture of the Shaft of the Femur in a Boy of Five Years.

of deformity has been slow more than one attempt may be necessary to overcome the restriction in abduction.

**Shaft of Femur.**—Fracture of the shaft of the femur is the most frequent fracture of the lower extremity in childhood. The line of fracture is

usually in the upper or middle third, usually follows direct violence when it is transverse and indirect when it is spiral. In fractures involving the upper third the proximal fragment is usually flexed, abducted and rotated outward but may be displaced internally and posteriorly, the distal fragment being drawn upward and inward. With injuries in the middle of the bone the displacement depends on the direction of the violence. All signs of fracture are usually present.

Fig. 65.—Bilateral Fracture of the Shaft of the Femur in a Boy of Eight Years.

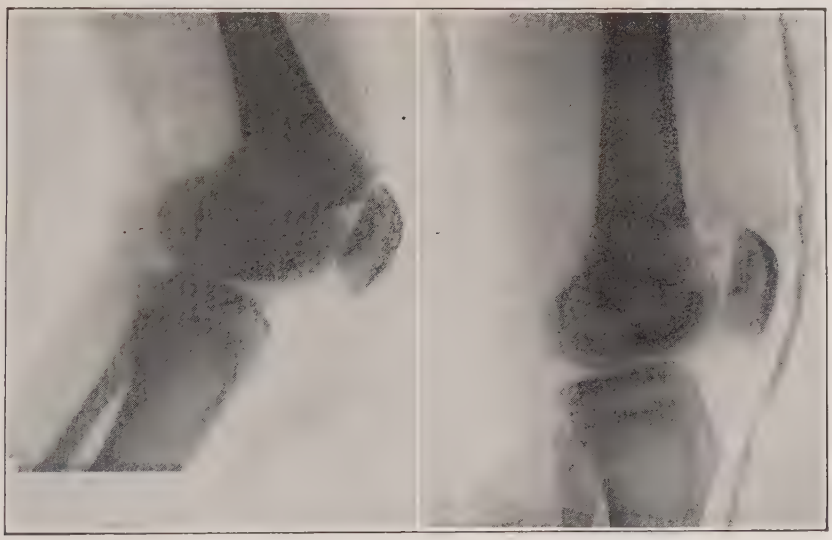
*Treatment.*—No effort to reduce existing deformity and to maintain reduction should be spared and yet it must be understood that perfect anatomical reduction is not essential for a perfect functional recovery. Shortening is not always permanent. Even where shortening persists it is compensated for by slight tilting of the pelvis. Ashhurst states: "The bones depend for their form on the action of muscles and in the daily use of the limb almost any deformity of the shaft of a long bone in a young child will be spontaneously corrected within six months or a year." Where there is marked angular deformity this may be exaggerated and it there-

fore follows that alignment is more important than end-to-end apposition. If the condition of the patient warrants it anesthesia should be induced and the bone ends locked if possible. Treatment varies somewhat according to age. Before the age of five or six vertical suspension is probably the best mode of treatment. By means of lateral moleskin straps extending

Fig. 66.—Fracture of the Lower Extremity of the Femur in an Infant of Eight Months.

from the top of the thigh both legs are vertically suspended by ropes passing through pulleys and attached to weights sufficient to elevate the buttocks about two inches from the bed. Sufficient play should be allowed for between the feet and pulley so that the buttocks may be raised without buckling by pressure of the feet against the pulleys. Coaptation splints may be applied about the site of the fracture. The legs should be suspended

in an abducted position. When there is much overriding more traction may be obtained by suspending the injured leg alone though this is not so comfortable or convenient. Suspension may be discontinued at the end of four weeks and the patient kept in bed for two weeks longer. With older children the best routine with which I am familiar is that described by Burdick. After reduction under anesthesia traction straps are applied and a spica extending from the ribs to the malleoli is applied with the limb in moderate abduction. The cast is removed after six weeks and after two weeks in bed with massage the child is allowed up on crutches. In compound fractures suspension with traction and countertraction by means



A B

FIG. 67.—*A*. SEPARATION OF THE LOWER FEMORAL EPIPHYSIS IN A BOY OF FOURTEEN YEARS. *B*. SAME CASE AFTER REDUCTION.

of a Thomas splint and Balkan frame is indicated. Skeletal traction may be applied by means of calipers. Open reduction is very rarely necessary and usually for interposition of soft parts between the fractured surfaces.

**Lower Femoral Epiphysis.**—Any case of injury to the knee in a patient under twenty suggests an epiphyseal separation. The epiphysis includes the complete lower articular surface of the femur. There may be a simple loosening of the epiphysis with slight displacement or there may be marked displacement of the fragment forward and upward in front of the lower end of the shaft. In this type serious complications may be associated due to the violence of the injury or to the projection backward of the end of the diaphysis. Pressure on the vessels or even rupture may result and amputation become necessary. The nerve injury is usually to the external

FIG. 68.—CASES IN BRYANT'S FRAME WITH SUSPENSION. (Burdick and Siris. Courtesy of *Ann. Surg.*)

FIG. 69.—PLASTER SPICA WITH EXTENSION. (Burdick and Siris. Courtesy of *Ann. Surg.*)

popliteal with a resulting toe drop. Hyperextension is the usual form of injury and a quite frequent cause is the involvement of the leg in the spokes of a moving wheel.

*Clinical Features.*—When the displacement is marked there is great prominence of the patella with a transverse depression across the thigh

just above the knee. There is a bony prominence in the popliteal space, mobility and soft crepitus just above the joint. Interference with circulation and nerve injury may be present. In the case of the slighter degrees of displacement a roentgenogram, which should be had in every case, may be the only means of diagnosis. The tendency to displacement after reduction is very great and recourse should be had to repeated x-rays. There may be interference with growth with resulting shortening.

*Treatment.*—It is important that accurate reduction be secured at the earliest possible moment. Where there is little deformity and reduction has been accomplished, immobilization by means of plaster of Paris with the

FIG. 70.—DETAIL OF TRACTION STRAPS AND LOWER END OF PLASTER CASE IN TREATMENT OF FRACTURE OF SHAFT OF FEMUR.

Dorsiflexion of foot maintained by means of elastic sling.

knee in slight flexion is sufficient. In those cases with marked displacement, traction on the lower leg with the thigh elevated and the knee flexed will tend to reduce the displacement. After reduction the knee should be maintained in flexion beyond a right angle. Where there is a tendency to recurrence of the displacement a position of acute flexion should be maintained. The circulation must be carefully watched and the position verified by frequent roentgenograms during the first two weeks. When reduction cannot be accomplished by closed methods open operation is indicated. Where the tendency to recurrence of the displacement persists, fixation of the fragment is necessary.

In the case of partial separation seen after union has occurred it is best to refrain from operation for a period of months as there is a great tendency to restoration of form.

FIG. 71.—FRACTURE OF PATELLA IN A BOY OF THIRTEEN YEARS. (Case of Wm. A. Downes.)

**Patella.**—Fracture of the patella is very rare in childhood but should be treated on the same principle as in adult life. Open reduction and suture with absorbable sutures on the fifth to seventh day after the accident is the method of choice.

**Both Bones of Leg.**—Fractures of both bones of the legs are not infrequent in early life and the lower third is the most frequent site. In

FIG. 72.—SAME CASE AS IN FIGURE 71 AFTER OPERATION.

fractures of the leg there are certain differences from those in adult life. The tibia alone may be broken, the fibula having sufficient elasticity not to break. When the fracture is oblique it rarely involves the joint, the epiphyseal cartilage apparently acting as a buffer. Where there is no de-

formity localized bony tenderness following trauma is sufficient to suggest fracture which may be revealed by the Roentgen ray. A fracture from direct violence may be in any part of the leg and is usually transverse. Indirect violence usually results in oblique or spiral fracture in the lower

Fig. 73.—Fracture of Shaft of Tibia in an Infant of Three Months.

third. Swelling is often extreme and blebs and blisters are not infrequent. Reduction should be accomplished under anesthesia and maintained by means of a circular plaster case from mid thigh to toes. As soon as the plaster is set, the case should be split to avoid the possibility of injurious pressure as a result of swelling. When satisfactory reduction of the tibial

FIG. 74.—FRACTURE OF BOTH BONES OF THE LEG ABOVE THE ANKLE JOINT.

injury has been obtained the fibula may usually be disregarded. When there is much swelling a boxwood splint or Cabot's wire splint may be utilized. Where reduction cannot be maintained traction and suspension in a Thomas splint are indicated. Traction is secured through moleskin, the Sinclair skate or a Steinman pin through the os calcis. External rotation of the lower fragments is to be guarded against. Union is frequently delayed in the

lower third, and eight weeks should ordinarily be allowed for consolidation. Non-union occurs more frequently than in any other region. As soon as the plaster is removed daily massage should be begun. While Pott's fracture rarely occurs there are injuries around the ankle joint such as fracture of the internal malleolus or separation of the lower tibial epiphysis. Reduction is maintained by means of a circular plaster case from just below the knee to the toes with the foot inverted and at right angles. The Stimson molded splint may be used. In convalescence the tendency to flat-foot is counteracted by raising the inner sole and heel one-quarter inch.

FIG. 75.—CONDITION RESULTING FROM THE PRESSURE OF A CIRCULAR PLASTER CASE APPLIED IMMEDIATELY AFTER INJURY IN WHICH NO PROVISION WAS MADE FOR SWELLING.

The case should have been split as soon as the plaster was hard.

**Compound Fractures.**—The principles of the treatment of compound fractures are the same in children as in adults. Further infection is avoided by immobilization and the application of a sterile dressing. As soon as the hospital is reached the child is anesthetized (unless in a state of severe shock), the wound protected with a piece of sterile gauze and the surrounding skin scrubbed with green soap which is washed off with alcohol followed by benzine. The wound itself is then cleansed and the whole area painted with half strength tincture of iodin. When there is extensive laceration a careful débridement is done and the wound thoroughly washed out with ether. All bleeding vessels are secured. The ends of the bone are mechanically cleansed and if necessary the rongeur and curet are used. Where the wound is small and there is relatively little contamination as in those wounds made

by the end of the bone, healing will often occur without material infection. When, however, the wound is lacerated and grossly contaminated chemical sterilization by the Carrel-Dakin method is indicated. The fracture is immobilized by traction and suspension. For further details the reader is referred to the larger textbooks.

**Emergency Treatment.**—In the transportation of children with fractures the chief points to be considered are the prevention of any further injury and the assurance of as much comfort as is possible to the patient. In fractures of the humerus the arm may be bound to the side, the chest serving as a temporary splint. In fractures of the thigh and leg the limb should be held fixed to an improvised splint. The ideal and most effective method of immobilization for transport in injuries of the extremities is by means of the Thomas splint which unfortunately is rarely available.

When there is a wound associated with the fracture a sterile dressing should be applied or in its absence a clean, freshly ironed handkerchief or towel. No attempt at reduction should be made until the hospital is reached, when thorough cleansing of the wound may be carried out.

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# CHAPTER XII

## DISEASES OF BONE

### GENERAL CONSIDERATION

With the exception of tumors of bone, osteomyelitis resulting from trauma and infection from the surface of the body, and certain rare constitutional diseases, affections of the skeleton occur with greatest frequency in the period of childhood. There are few diseases involving the bones which do not, in some degree, interfere with growth and result in permanent defects. The study of the inflammatory diseases is particularly important as their early recognition and prompt and effective treatment have a great bearing on the length of convalescence and the degree of permanent defect.

**Anatomy.**—Early in fetal development a long bone is represented by hyalin cartilage. About the fortieth day there appears in the center of the cartilage an area which is transformed into bone. This area extends from either side by calcification and subsequent ossification. At the same time as this ossifying area extends the bone as a whole increases in size but the masses of cartilage situated on either side of the central bony portion diminish in length relative to the total length of the bone. At birth, or within the first six months of life, complementary centers of ossification begin to appear in the ends of the remaining portion of cartilage. Finally there remain of the original hyalin cartilage only two disks situated between the bony shaft, which is called the diaphysis, and the ends also ossified which are known as epiphyses. This remaining disk of cartilage is known as the epiphyseal or conjugal cartilage. That portion of the shaft adjacent to the epiphyseal cartilage is called the metaphysis. This is the most vascular portion of the bone and as a direct result is the common site of origin of inflammatory disease. While the epiphyseal cartilage lays down bone from either side its formative power is infinitely greater on the side toward the diaphysis and it is here that the growth of the diaphysis occurs. Ombredanne has compared the epiphyseal cartilage to a mason laying down successive layers of brick in a wall and retiring as the wall increases in thickness. There are three stages of development between the diaphysis and the growing epiphyseal cartilage. Next to the cartilage is an area of changed cartilage, then a zone of tissue in process of calcification and next to the diaphysis an area of young bone. Although there is an epiphyseal cartilage

at each end of a long bone one is much more active than the other and this one is known as the fertile epiphysis. The fertile epiphyses of the more important long bones are situated near the knee and distant from the elbow. The epiphyses showing the greatest proliferating power are the ones situated at the lower end of the femur, the upper end of the tibia, the upper end of the humerus and the lower end of the radius. In the child the periosteum is relatively thick and vascular. For our purposes it is well to consider the layer of osteoblasts by which the bone increases in diameter as forming a part of the inner layer of the periosteum. This increase in diameter has its bearing on the application of metallic plates, bands and wire sutures in fractures in children.

A direct injury to the epiphyseal cartilage, whether it be a fracture line extending to the cartilage or through the metaphysis, or a partial or complete separation of the epiphysis may diminish bone growth, but rarely if ever increases it. However, a fracture of the diaphysis occurring in the period of active bone growth with resulting immediate shortening often appears to stimulate the osteogenic power of the epiphyseal cartilage as the shortening is usually overcome in the process of growth. Inflammatory disease of the bone, near to or at a distance from the epiphyseal cartilage, has a tendency to decrease bone growth. In certain instances of spina bifida occulta the epiphyseal cartilage is affected and there results an inequality in length of the two lower extremities. Anterior poliomyelitis influences the activity of the epiphyseal cartilage and even when the muscles are relatively slightly affected there may at times be a progressive shortening of the affected extremity.

## DEVELOPMENTAL DISEASES

**Achondroplasia.**—Achondroplasia is a diminution in the bone-forming power of the epiphyseal cartilages. Its etiology is unknown, it is always congenital and may be hereditary. The condition is manifested exclusively in those bones laid down in cartilage. The exact process varies in different cases and while it is congenital the condition may only become evident as growth proceeds.

*Clinical Features.*—Achondroplastics are dwarfs. The extremities are shorter than normal and that portion nearest the trunk is affected to the greatest degree. While the bones are shortened their diameter is not decreased. The trunk and abdomen develop disproportionately to the short extremities. The head appears large because the dimensions of the cranium are relatively normal while the face is small. There may be more or less interference with movement in the various joints. The intellect is as a rule not affected. The muscular development is good.

*Diagnosis.*—The two conditions which have been confused with achondroplasia are rickets and cretinism. To distinguish the former a roentgenogram is of service in showing the distinct outline of the epiphysis in the condition under consideration, while in rickets the outline is wavy and indistinct. The facial expression serves to distinguish the achondroplastic from the cretin, the latter appearing mentally deficient. In the roentgenogram there is, in the cretin, a line of dense bone in the region of the metaphysis.

*Treatment.*—There is no specific treatment. In the event of suspicion of thyroid insufficiency glandular therapy should be tried.

Fig. 76.—Osteogenesis imperfecta, Girl Three and a Half Years Old.

**Cretinism or Congenital Myxedema.**—The treatment of this condition which results from congenital thyroid insufficiency is one of the triumphs of glandular therapy. It is associated with a disturbance of the ossification of the epiphyses and a delay in the disappearance of the epiphyseal cartilages.

*Clinical Features.*—While the clinical features are striking and characteristic it is surprising how often the condition is overlooked until a considerable period of time has passed. The appearance is stupid, the tongue protrudes, the lips are thick, the skin is dry, there is delay in closure of the fontanels, the teeth are late in erupting and there is delay in walking. The activity of the epiphyseal cartilages is interfered with and an area of dense bone, which gives a characteristic x-ray picture, is developed in the metaphyses. As a result there is greatly deferred union of the epiphyses.

*Treatment.*—Under thyroid administration the condition is improved, the degree of improvement depending upon the stage at which the disease is recognized and treatment established.

Osteogenesis imperfecta has been referred to under intra-uterine fractures (page 69).

Osteopsathyrosis is probably the same, or a related condition occurring in apparently healthy but frail children. Due to lack of periosteal bone for-

Fig. 77.—Fracture through Bone Cyst, Upper Extremity of Right Femur, in a Girl of Thirteen Years.

mation there is atrophy and softening of the bone with the result that multiple fractures from slight trauma occur in early life.

### Multiple Cartilaginous Exostoses

**Dyschondroplasia.**—This congenital disease, the antithesis of achondroplasia where there is an arrest of development, is often hereditary and is distinguished by the presence throughout the skeleton of multiple and often symmetrical cartilaginous exostoses.

*Etiology.*—There is an irregular activity of the epiphyseal cartilage—there may be an expansion of the extremities of the bone as well as the formation of multiple chondromata or exostoses. The epiphysis is small and irregular and may show premature ossification. Associated deformities are lateral curvature of the spine, knock-knee, relative disproportion be-

Fig. 78.—Recurring Fracture through Bone Cyst of Femur.
First fracture at age of fifteen years.

tween the growth of the radius and ulna with bowing of the forearm and sometimes dislocation of the head of the radius.

*Diagnosis.*—The condition is distinguished from bone cysts and enchondromata by its general distribution revealed by roentgenograms.

*Treatment.*—Treatment consists in removal of those exostoses causing pain or pressure on nerves.

**Osteitis fibrosa cystica.**—In this condition there is an excessive development of fibrous tissue in the marrow area resulting in the formation of cysts and weakening of that portion of the bone affected. The shafts

of the long bones is the common site. The most common type is that in which one bone is affected. There is a much rarer form in which many bones are involved. The etiology is in doubt.

*Diagnosis.*—The generalized type is usually easily recognized. In the case of solitary cysts the recognition may be accidental or a dull pain may suggest a roentgenogram which reveals the lesion. In early life a central

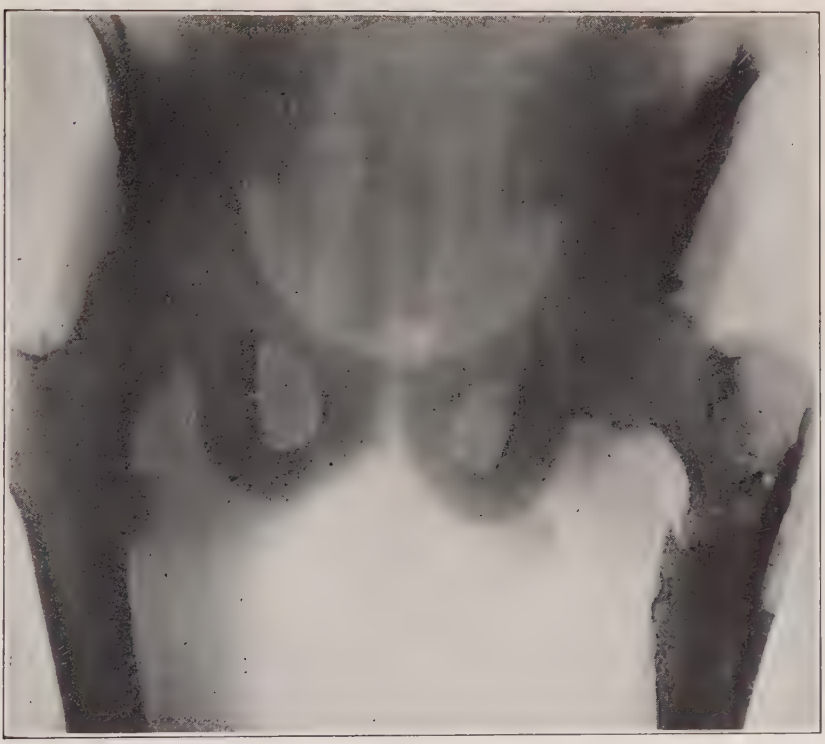

Fig. 79.—Same Patient as in Figure 78 One Year Later, Six Weeks after Introduction of Bone-Graft.

lesion with an intact cortex in the shaft of a long bone is almost invariably a bone cyst. Oftentimes it is first recognized through the occurrence of a fracture.

Prognosis is good in the solitary lesion. Operation usually results in cure. The stimulation to bone growth from fracture through the cyst often results in obliteration of the lesion.

*Treatment.*—In the solitary cyst, operation is indicated if there is evidence of increase or if the lesion is so extensive as to jeopardize the integrity of the bone. The cyst is exposed, its interior curetted, the cavity partially obliterated by crushing in the wall, and if necessary a bone-graft is intro-

duced. Where fracture has occurred opportunity is given for the natural obliteration of the cavity. If the condition remains a bone-graft is introduced.

**Myositis ossificans (traumatica).**—Myositic ossificans traumatica is a localized formation of bone in the muscles. The chief causative factor is trauma though there is probably an associated congenital predisposition.

Fig. 80.—Fracture through Bone Cyst of Upper Extremity of Humerus in Boy of Eleven Years.

*Clinical Features.*—Following a trauma there is the ordinary swelling, ecchymosis and pain. However, in about two weeks, it is noticed that the mass persists, or may even increase in size and become firmer. In three or four weeks roentgenographic examination reveals evidence of bony deposits parallel to the shaft of the bone. After this the process remains stationary or tends to regress. This feature together with the horizontal arrangement

of the bony deposits serves to differentiate the condition from periosteal sarcoma.

*Treatment.*—Treatment consists in rest. Operation for removal is definitely contra-indicated until a period of several months has elapsed without spontaneous absorption. After this period if the bony deposit persists and causes symptoms, it should be removed.

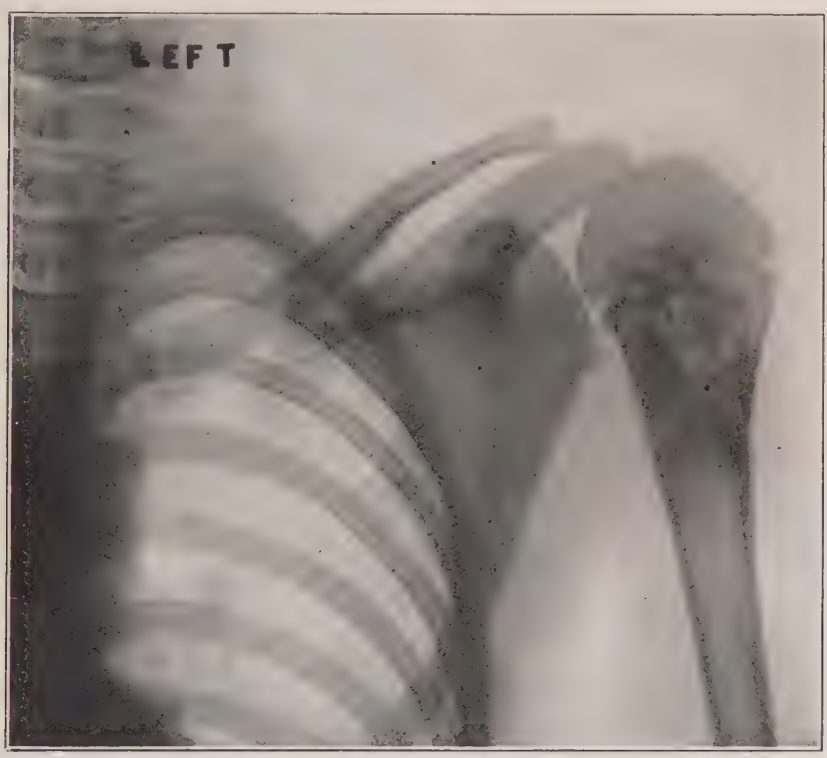


FIG. 81.—SAME PATIENT AS IN FIGURE 80 SIX MONTHS LATER TO SHOW THE PROGRESS OF OSSIFICATION.

## TUMORS OF BONE

As in other structures, tumors of bone may be benign or malignant, primary or secondary. Approximately 10 per cent of the malignant tumors observed in children originate in the skeleton.

### BENIGN TUMORS

**Osteoma or Exostosis.**—When the tumor projects from the surface of a bone it is called an exostosis.

One type arises from bones developed in membrane, such as the flat bone of the skull. It is dense like ivory and the term ivory exostosis is

employed. The symptoms are those of pressure and surgical removal is the only available treatment. While the ivory exostosis is occasionally observed in children the growth is so slow that operation is usually not indicated until adult life.

The cancellous osteoma or exostosis occurs more frequently and its production is limited to the period of active bone growth. These so-called

Fig. 82.—Osteoma of Humerus in a Girl of Eleven Years. (Case of J. J. Westermann.)

tumors are probably due to defect and irregularity of growth and may represent a minor degree of dyschondroplasia. The exostosis forms a rounded or mushroom-shaped tumor, is most common on the long bones in the neighborhood of the epiphyseal line, is often multiple and may be hereditary. Its top is invested with a cap of cartilage and growth persists until the cartilage is ossified. The subungual exostosis observed under the nail of the thumb or great toe is of this type. An exostosis in the vicinity of a joint may

be surmounted by a bursa and this bursa, while usually of adventitious origin, may be derived from the synovial membrane of the adjacent joint and communicate with the joint cavity.

The symptoms depend upon the situation and the diagnosis is made from the slow growth and the characteristic roentgenogram.

When an exostosis causes symptoms it should be removed, care being taken to make the removal complete.

**Chondroma.**—These tumors are similar in origin to the exostoses and are composed of cartilage. They usually project from the surface of the bone but may arise from the interior and expand the cortex, in which case they are known as enchondromata and may be confused with bone cysts. The long bones, including the phalanges, are chiefly affected, and while the growth may be single it is frequently multiple. The cartilage composing the tumor may undergo myomatous degeneration or may take on a malignant character and develop into a chondrosarcoma.

The treatment consists in removal with as little disturbance as possible to the continuity of the bone. In multiple chondromata of the hand the largest tumors should be removed and radiotherapy tried to inhibit the growth of the smaller ones.

Fibroma may be met with as a periosteal growth, usually in the mouth from the alveolar border, the simple epulis, or in the pharynx the nasopharyngeal polypus.

Giant-cell tumors are rarely observed before late childhood. Such a tumor occurs as a central growth in the extremity of a long bone and usually involves the epiphysis. The growth is slow, causes little pain, and there is progressive destruction of adjacent bone. On incision an irregular cavity is disclosed filled with material not unlike vascular granulation tissue and which has been said to resemble currant jelly. A roentgenogram reveals an irregular cystlike area in the extremity of the bone which may be multilocular in appearance. In exceptional instances they have been known to give rise to metastases but in general they are essentially non-malignant.

*Treatment.*—Complete local removal with cauterization of the wall of the cavity usually results in cure. If there has been such progression as to materially weaken the bone, more radical measures, such as resection, may be necessary.

## Malignant Tumors

The primary malignant tumors of bone comprise:

1. The osteogenic sarcoma originating from the osteoblast at some stage of its development.
2. The myeloma arising in the bone marrow.

3. The endothelioma which takes its origin from the blood-vessels or lymphatics.

The osteogenic sarcoma is encountered most frequently. This tumor grows from the inner layer of the periosteum, the periosteal type, or from the endosteum of the medulla, the medullary type. It is often impossible to determine the site of origin on account of the rapid growth of the tumor and the destruction of the surrounding parts. If the tumor is largely on the outside of the bone and the cortex is not completely destroyed it may be assumed to be periosteal in origin. The long bones are most frequently involved and the favorite site is in the region of the metaphysis. The periosteal tumor is rapid in growth, invades the surrounding tissues at an early period, and forms a large tumor mass. The amount of bone production varies and in the most malignant type the mass may be quite soft in consistency. When the growth is advanced there is usually a characteristic roentgenographic appearance in the surface erosion of the cortex with lines of calcification radiating outward. In the medullary type the end of the bone may be expanded, later there is destruction of cortex, the surrounding soft tissues are invaded and a large mass is formed. The roentgenographic appearance is at first that of an area of bone absorption and later that of complete destruction of a segment.

The myeloma is exceptional in children, is characterized by the formation of multiple tumors, both in the long bones and in the bones of the skull, and the appearance of the Bence-Jones reaction in the urine.

The endothelioma originates usually in the medulla but sometimes in the periosteum, invades the cortex and involves the surrounding soft parts. The roentgenographic picture may be confused with that of osteomyelitis as there is a peculiar striated appearance of the shaft without bone formation.

**Clinical Picture.**—Pain is usually the first symptom but, as a matter of fact, it is often the appearance of a swelling that directs attention to the tumor. Metastasis to the lung usually occurs early. The general use of Roentgen examination after trauma or on account of pain will doubtless result in more frequent early diagonsis.

**Diagnosis.**—The diagnosis of bone tumors is peculiarly difficult and it is rare that any one surgeon has the opportunity to observe clinically a considerable series of such cases. According to Bloodgood a central lesion with an intact bone shell in the shaft of a long bone in a patient under fifteen years is quite certain to be a benign bone cyst. When the extremity of the bone is involved differentiation between a giant-cell tumor and an early medullary sarcoma may be impossible. The epiphysis itself is more frequently involved by the giant-cell tumor. Brodie's abscess or tuberculosis when manifested as a single caseous area or abscess in the shaft or extremity may be

impossible to differentiate from a bone cyst. It is usually only in advanced cases that an absolutely definite diagnosis may be made from the clinical picture and Roentgen ray examination. In any case a mutilating operation should be preceded by an exploratory incision with microscopic examination of removed tissue.

The prognosis in malignant bone tumors in children is almost uniformly bad.

**Treatment.**—By the time the diagnosis is made the possibility of cure is usually very slight. The surgical treatment consists either in resection or amputation. Even in the presence of known metastases amputation is justified for the relief of pain. Radiotherapy should be employed in conjunction with surgery.

## ACUTE OSTEOMYELITIS

Under this term is included infections of bone other than tuberculosis and syphilis. Osteomyelitis is an inflammation of the bone marrow. While periostitis may exist as a definite pathological condition it is as a rule secondary to an osteomyelitis. Bone marrow occupies:

1. The medullary cavity and the cavities of spongy bone.
2. All the haversian canals which form a communication between the surface of the bone and the medullary canal.

Bone is a type of connective tissue in which the groundwork has been impregnated with lime. This framework is itself relatively inert but it is bathed in the bone marrow and as there is free communication between cancellous bone and periosteum by means of the haversian canals it is not reasonable to assume that an acute infection can be limited to either cancellous bone or to the periosteum.

**Anatomical Considerations.**—Certain anatomical considerations are of importance in relation to the localization of the infection.

**Blood Supply.**—The circulation of an ordinary bone is derived from three sources. The nutrient artery is the main supply and enters the shaft at about its middle; dividing, it sends branches to either extremity which ultimately terminate in fine capillaries in or near the metaphysis. There is a vascular zone adjacent to each joint, located in the periarticular tissues and from which vessels pass into the bones. When the ligaments and synovial reflection of the joint extend so as to include the metaphysis within their attachments, the vessels enter the metaphysis directly. When such a relationship exists there is obviously a greater liability to the occurrence of joint inflammation as a complication of osteomyelitis. This is illustrated in infection of the upper and lower extremities of the femur and the lower extremities of the humerus and radius. On the other hand, when the joint

connection does not extend beyond the epiphysis the blood-vessels reach the metaphysis only after passing through the epiphysis and epiphyseal cartilage, and there is less likelihood of a secondary infection of the joint. A further fact bearing on the interassociation of bone and joint disease is that the periosteum, continuing down from the shaft, dips into the epiphyseal line and becomes densely adherent at this point, thus tending to oppose the ex-

Fig. 83.—Acute Osteomyelitis of Third Metacarpal in Boy of Two Years.

tension of infection from bone to joint. The cortex of the shaft receives its blood supply from the periosteal vessels.

**Importance of the Metaphysis.**—The metaphysis, that portion of the bone between the epiphysis and the diaphysis in which growth is most active, is a very vascular area. It is also the area in which injury occurs most easily as a result of trauma. These peculiarities explain the great frequency of inflammatory bone disease in children as well as its localization.

**Etiology.**—Infection of the bone may occur by way of the lymph stream, by direct continuity from a neighboring focus, by implantation from the surface of the body as a result of trauma. In children, however, osteomyelitis is almost invariably a blood-borne infection. The bone lesion is the local evidence of a general infection. Bacteremia, often transient and symptomless, is a common occurrence in childhood. After birth a child comes into contact with many sources of infection and while acquired immunity is developing, it is reasonable to assume that the blood stream serves as a carrier of organisms more frequently and for longer periods than is true in

adult life. The avenues by which organisms gain entrance to the blood stream are varied and the portal of entry may be the tonsils or mouth cavity, but most frequently some local skin infection serves as the primary focus. In early infancy the umbilicus is a frequent focus. Examination of

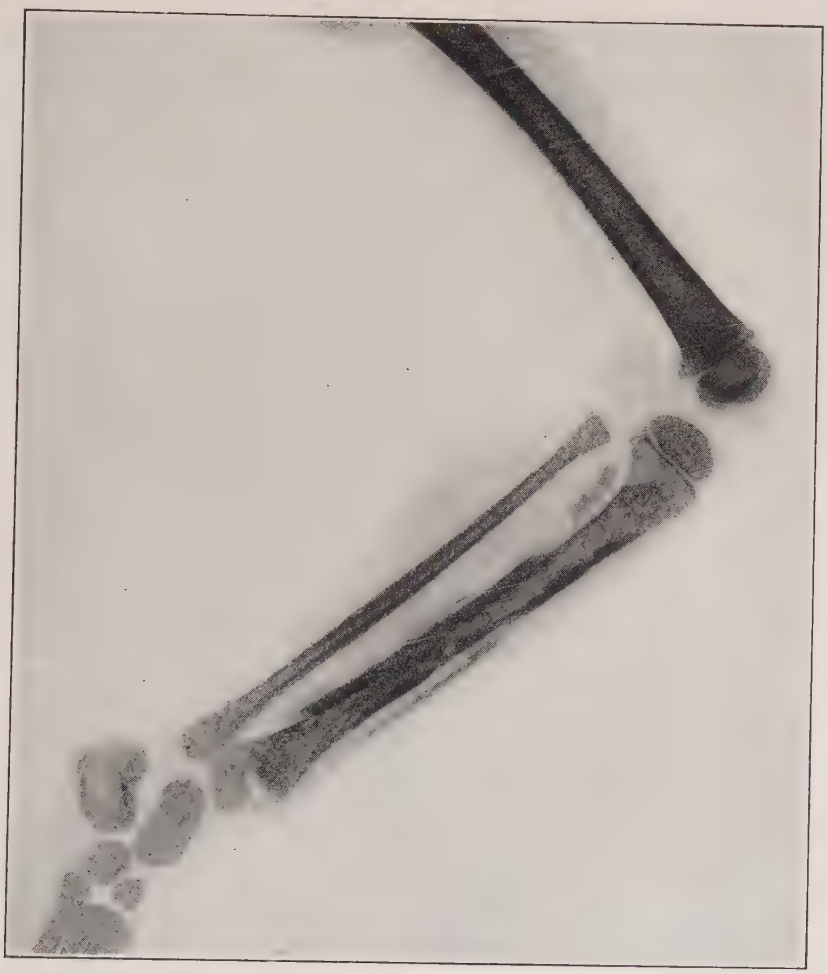

Fig. 84.—Chronic Osteomyelitis, Sequestration of the Entire Shaft of the Tibia, Child of Three Years.

the ears should not be omitted, as a chronic otitis media may be the source of infection.

As a result of the capillary anastomosis the metaphysis serves as a kind of sieve and organisms circulating in the blood are apt to be delayed or lodged in this situation. Trauma plays a part and is probably the deciding factor in determining the site of invasion. Slight trauma, a blow or twist, is often sufficient to produce a small hemorrhage into the metaphysis. Re-

Fig. 85.—Chronic Osteomyelitis, Lower Extremity of Femur, Child of Four Years.

sistance is lowered at this point, a deposit of organisms occurs and infection results. Lowering of the general resistance by ill health may also be a contributory factor.

**Age and Sex Incidence.**—Acute osteomyelitis is a disease of childhood and is most common in the period from two to ten years. At this time bacteremia is frequent, the metaphysis is very vascular and is most susceptible to slight injuries. Boys are affected more frequently than girls.

**Organisms.**—The most frequent offending organisms are the *Staphylococcus aureus* and the pneumococcus. The streptococcus occurs next in frequency in older children and is the most frequent infective organism in children under one year.

**Pathology.**—The long bones are usually affected and often at the site of the fertile epiphysis. While any bone may be involved the condition is rare in the cranium and scapula.

The offending organisms passing through the fine capillaries of the metaphysis are arrested at the site of a hemorrhage resulting from trauma, and a small inflammatory area results. The focus of infection in the metaphysis spreads rapidly towards the periosteum in the direction of the epiphyseal line. Pus is formed under the periosteum and, spreading rapidly, strips the periosteum from the bone. As the spread of the infection is less rapid through the cancellous tissue to the medullary canal the involve-

ment of the medullary canal may be secondary from the periosteal origin through the haversian canals.

Roentgenograms made in the early stages are always negative. Only when there has been gross destruction of cancellous bone or formation of new bone under the periosteum does the roentgenogram give definite evidence of disease. The absence of Roentgen ray findings does not in any way militate against the making of a diagnosis of acute osteomyelitis. This point cannot be overemphasized.

The firm attachment of the periosteum at the epiphyseal line tends to prevent direct extension into the joint. As the inflammatory process extends, the bone lamellæ are bathed in pus and as a result of the toxic influence necrosis ensues. The cortical bone is more dense and resistant and until its circulation, derived from the periosteum, has been interfered with its vitality is assured. Even before the periosteum is perforated the overlying soft tissues are involved with a resulting cellulitis.

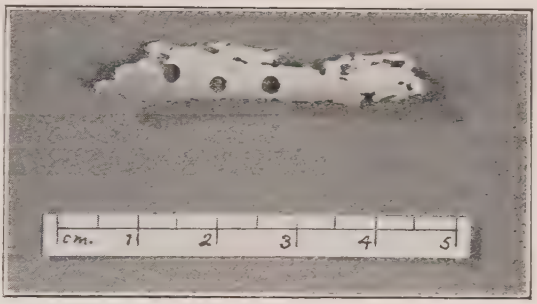


Fig. 86.—Sequestrum.

When the acute spread of the infection is arrested either spontaneously or by surgical intervention, nature sets to work to provide for the disposal of that portion of the bone which has undergone necrosis. There is a deposit of new bone in the subperiosteal region, resulting in the formation of a bony wall or involucrum. To provide for the escape of inflammatory products from within this bony covering, it is perforated by sinuses called cloacæ. In the interior of the bone there is a formation of vascular granulation tissue and in process of time this leads to the separation of the dead bone. The detached portion is called the sequestrum. The smaller sequestra pass out through the cloacæ and if not removed by surgical intervention even the larger sequestra are eventually broken up and disposed of. The shaft is gradually reformed and the subperiosteal bone tends to disappear. As acute osteomyelitis is usually the local manifestation of a general process, it is not surprising that there are frequently metastatic abscesses, either in the bones or soft parts with all the evidences of a pyemia.

**Clinical Features.**—Within a short period following a fall or slight injury there is a sudden agonizing pain in the region of a joint. In many cases, however, there may be no history of an injury and the condition is attributed to exposure or fatigue. A discharging ear, a sore throat, a furuncle or a small infected wound of the skin, or some other source of infection may have

preceded the condition and the general health may not have been as good as usual. Accompanying the pain there is localized tenderness. Depending upon the type of infection and the general condition of the child there is more or less general reaction and evidence of toxemia. Later there is local evidence of inflammation, redness, swelling and edema. These are the fundamental signs of acute osteomyelitis, but there are few surgical affections with such wide variations in clinical types depending upon the nature and virulence of the infecting organism, the site of the lesion and the age of the patient. In the fulminating type, within twenty-four hours after a sudden onset the child is found to have a temperature of 105°, pulse 150-160 and a leukocytosis of 20,000-40,000. The skin is clammy and slightly cyanosed, the tongue is dry and the teeth covered with sordes. The child is often too ill to direct attention to the local lesion but on careful examination the local signs of osteomyelitis are noted in one extremity. If the swelling in the epiphyseal region is incised only a serous exudate may be revealed and when the bone itself is drilled there is no evidence of pus. If the child lives long enough for a dressing the wound will be found dry, appearing almost as if it had been seared with a hot iron. The diagnosis may be difficult as the picture may be that of a profound sepsis and there may be little to call attention to the local lesion. This type is usually caused by a virulent streptococcus. In another type, similar to the above but somewhat less severe, operative intervention is followed by a drop in temperature and a greatly improved general condition. Thirty-six to forty-eight hours later a new focus appears and a second operation is necessary. Further areas are involved and there is a progressive decline in the general condition, terminating in death, or the condition prolongs itself into months and months of illness possibly with final recovery, usually with much resulting disability.

All gradations of severity are noted from the fulminating to an attenuated form known as osteomyelitis serosa or albuminosa. After a mild but sudden onset the disease pursues a chronic course. Eventually there forms a subperiosteal collection of fluid and often a sequestrum. The fluid is serous or mucoid.

In the most common type, that of average severity after a sudden onset following a period during which health has not been quite satisfactory, the child is flushed and restless though the affected limb is kept absolutely still. The picture is that of fear that the limb may be touched or moved. On local examination the limb is found to be held in that position which relaxes the muscles and avoids pressure. There may be no swelling in the earliest stages but there is usually reddening of the skin. Both redness and swelling correspond to the affected bone. Tenderness, even in the earliest stages, is localized to the region of the involved bone.

**Diagnosis.**—The diagnosis must be made on the physical signs and in the majority of cases the symptoms and signs are so characteristic that there is little difficulty. In a child severe pain near a joint with extreme local tenderness is very suggestive. If in addition there is high temperature with leukocytosis, diagnosis is reasonably certain. A roentgenogram is of no assistance in early diagnosis but should be made as soon as possible when it does not interfere with prompt surgical treatment.

*Differential Diagnosis.*—A great many conditions may be confused with osteomyelitis. Cellulitis may usually be distinguished by the absence of intense pain or general illness. Erysipelas has a definite margin, there is less tenderness and less evidence of general disturbance. This condition is particularly confusing when it occurs on the shin. Freedom from temperature and inflammatory reaction characterizes subperiosteal fractures. In infantile scurvy the tenderness and unwillingness to move adjacent joints is suggestive but the lack of temperature and presence of submucous hemorrhages in the mouth serve to establish the difference. In rheumatism the onset is usually not so severe and the pain less marked. Furthermore, there is almost immediate swelling of the joint and the pain is in the joint itself. The affection is usually polyarticular. Infectious arthritis is sometimes difficult to differentiate. However, the muscle spasm, limited joint motion and early appearance of fluid in the joint are suggestive of arthritis. In early osteomyelitis the joints are not swollen and the motion may be free if gently elicited.

**Treatment.**—Early diagnosis and prompt and effective treatment largely determine the result in all but the fulminating types of acute osteomyelitis. Emphasis must again be placed on the fact that at the stage when treatment is most effective there is no change in the Roentgen ray appearance of the bone. Treatment consists in incision over the area of greatest tenderness through the skin, subcutaneous tissue and periosteum to the bone. This incision should be so planned as to lie on the diaphyseal side of the epiphysis to preserve the periosteal attachment to the epiphyseal line and if possible prevent extension into the joint. If no pus is encountered the periosteum is stripped for a short distance on either side of the incision. If there is no pus a series of three or four holes about ½ centimeter apart are drilled through the cortex obliquely downward toward the epiphyseal line, extending at least into the center of the shaft at the epiphyseal line. Even if pus is encountered beneath the periosteum it has been my practice to drill the holes described above, though this is considered unnecessary by some. Wide exposure of the medulla with the trephine or the hammer and gouge is neither necessary nor desirable, nor should the marrow be scraped out with a curet as this probably results in further dissemination of the

disease. The wound is drained with rubber dam or gauze impregnated with vaselin.

**Postoperative Care.**—The limb should be so splinted as to provide immobility to the part involved with access to the wound. Traction and suspension in a Thomas splint is an excellent method. Hot, moist dressings should be frequently renewed with as little disturbance to the patient as possible. Drainage material is removed as soon as the wound is lined with granulations. Continuous irrigation by the Carrel-Dakin method has many advocates. Attention to the general condition is of the greatest importance. If a sufficient quantity of fluid is not taken by mouth hypodermoclysis of 5 per cent glucose one or more times daily is indicated. Transfusion is of value, not only in those cases where anemia is a feature but also for profound toxemia. The diet should be simple and nourishing.

**Subsequent Course.**—After drainage has been established the time for further operation is determined by the separation of the sequestrum. One must usually rely on the Roentgen ray evidence for this information. When the conditions are favorable for operation the outline of the sequestrum is clear cut and distinct from the surrounding tissues. When it is decided that the sequestrum is free a channel is chiseled through the involucrum and the sequestrum lifted out. If the sequestrum is large, the opening in the involucrum is made over the center of the sequestrum which is then divided and the two portions removed separately. The granulation tissue lining the cavity from which the sequestrum is removed, is not disturbed. The cavity is drained with a small piece of rubber dam and the wound closed to the drain. If the cavity is too large to heal easily by granulation the edges are flattened to permit the soft tissues to fall in and obliterate it. It is often advantageous to carry out the operation in a bloodless field with the aid of a tourniquet.

**Prognosis.**—Where the disease has been recognized early and adequate surgical treatment carried out the outlook is good save in those cases where general infection is overwhelming. In the latter case judgment as to the time for interference is very important. It is not desirable to undertake, at any time, a radical removal of bone. It is impossible to decide which is viable bone and therefore it is important to wait until nature has separated the necrotic areas. It may, at times, be necessary to provide drainage when the wound has healed too rapidly. This, however, should be the limit of any operative procedure until it is time to remove the sequestrum. The curet is a dangerous instrument in the treatment of osteomyelitis.

A type of infection of bone is occasionally met with which, with rest and the application of wet dressings, may disappear without surgical intervention. In this form pain is not severe, there is little swelling, no reddening of the skin, and the general condition is good. The only sign which sug-

gests the diagnosis is localized tenderness. Where constant supervision may be had of such a child, it is justifiable to wait and observe the progress of the condition. In case of doubt an incision through the affected area, planned so as to avoid the neighboring joint, and carried through the periosteum will do no harm and may prevent extensive necrosis of bone.

## OSTEOMYELITIS IN INFANTS

**Acute Epiphysitis.**—There are certain peculiarities in osteomyelitis occurring in infants and this is particularly true in the first year. Two types are encountered, the acute and the subacute or chronic.

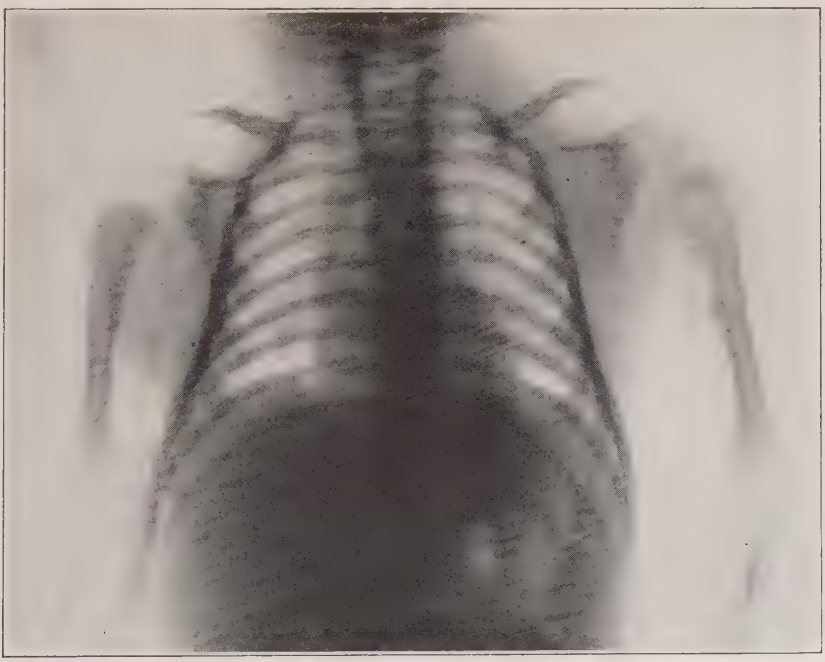

Fig. 87.—Acute Suppurative Epiphysitis in Five Weeks Infant Involving Upper Extremity of Humerus.

**Acute Osteomyelitis.**—The disease occurs most frequently in the acute form and the infecting organism is usually the streptococcus, less often the pneumococcus and least often the staphylococcus or gonococcus. The condition manifests itself as an arthritis. The joint affected is swollen, red and hot, and is held in that position which gives the greatest relaxation. When the baby is lifted so that the extremities are free, the immobility of the affected side is in marked contrast to the vigorous movements of the healthy limb. On careful observation, confirmed by very gentle palpation, it may become evident that the point of greatest swelling is over the bone to one

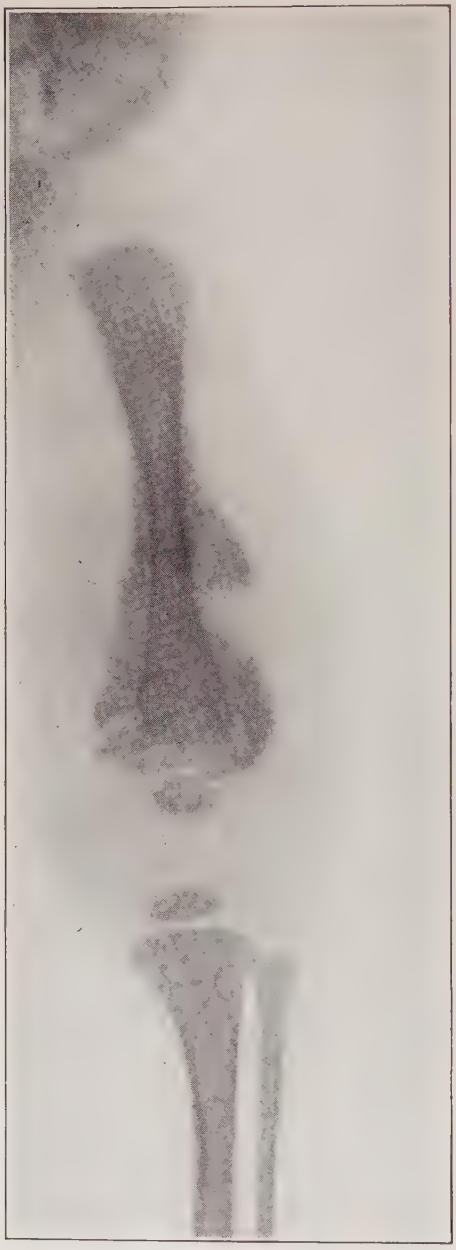

Fig. 88.—Acute Suppurative Epiphysitis in Child of One Month, Involving Lower Extremity of Humerus.

or the other side of the joint. Shortly there is fluctuation and the impression is that of an abscess in the region of the epiphysis. However, the first impression that the condition is an arthritis may prove correct. The acute osteomyelitis of infants is often localized in the region of the epiphysis itself or in the epiphyseal side of the conjugal cartilage. As a result the manifestation of the disease is almost immediately an arthritis since the infected zone is intra-articular. In a considerable proportion of cases more than one bone or joint is involved. The focal lesion is often difficult to demonstrate. In the general run of hospital cases the prognosis is poor and a mortality of 50 per cent is not unusual. The bone infection is merely an incident in a general infection. The local functional results are often surprisingly good if the child survives.

*Treatment.*—Careful general attention and repeated transfusion is just as important here as it is in any severe infection in infancy. If the greatest swelling is over the extremity of a bone an incision carried through the periosteum to the bone is indicated. Where there is fluctuation in a joint a small incision is made. In the former case a drain of rubber dam is used in the latter no drain is inserted. The joint is not immobilized at first and passive motion aids drainage. If the process does not clear up rapidly it becomes desirable to maintain the joint in that position most suitable in the event of ankylosis, the shoulder abducted and rotated externally, the elbow flexed to, or slightly beyond, a right angle,

the knee extended, the hip abducted and slightly flexed. Sequestrum formation is much less common in infants than in older children.

**Subacute or Chronic Type.**—In the neighborhood of a joint which is often held flexed and which is frequently the knee, appears an indolent swelling, fluctuant and only slightly tender. There may be no elevation of temperature. The differentiation between a tuberculous abscess and an abscess from an attenuated infection with a pyogenic organism is sometimes difficult. Aspiration and culture serve to make the diagnosis.

*Treatment.* — Aspiration, repeated as indicated, or evacuation of the pus through a small incision without drainage constitute the treatment.

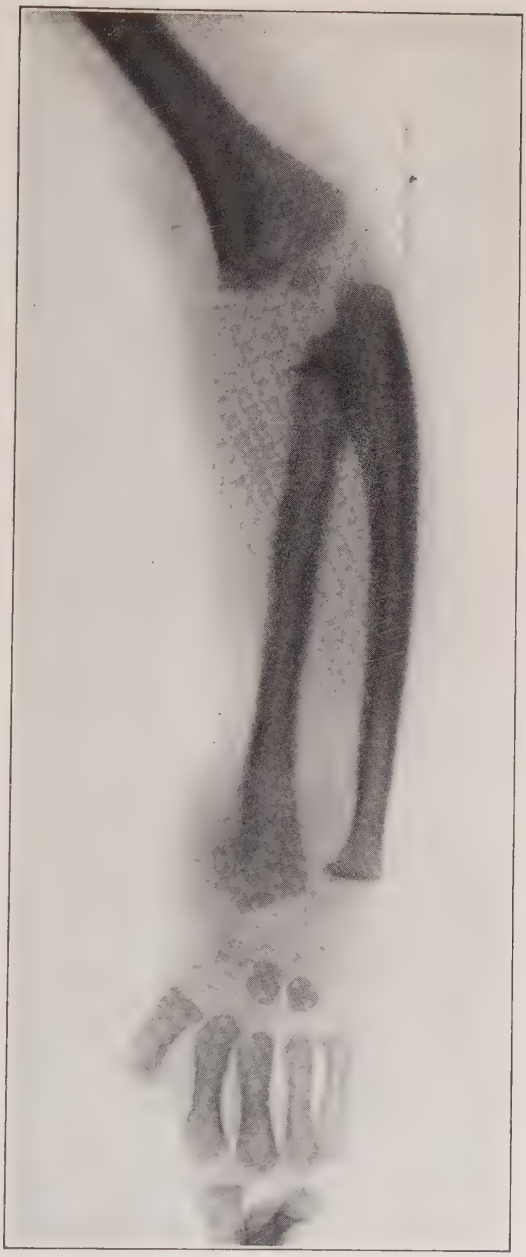

Fig. 89.—Acute Suppurative Epiphysitis of Lower Extremity of Radius, Infant Seventeen Months Old.

## BRODIE'S ABSCESS

Infection may retain its vitality for a long time and this is particularly true in infection of bone. Occasionally a cavity develops in cancellous bone, often in the upper extremity of the tibia or the humerus. The bone about this area is condensed. Probably this is due to the residual infection of an unrecognized osteomyelitis.

**Clinical Features.**—The chief feature is pain in the bone, greater at night when warmth in bed has increased the congestion. There may be, at times, edema over the area.

**Diagnosis.**—Diagnosis may only be definitely made with the aid of a roentgenogram.

**Treatment.**—Incision and drainage of the cavity in the bone either by means of a drill hole or by removal of the bony roof is the treatment indicated.

Fig. 90.—Tuberculous Dactylitis in Fifteen Months Infant.

## TUBERCULOSIS

Tuberculosis with the rarest exceptions is distinguished by early joint symptoms by involvement of the epiphysis and by multiple lesions. As such it has been discussed in Volumes VI and VII of this series.

Occasionally tuberculosis as a localized caseous area or abscess in the

shaft of one of the long bones presents a picture similar to Brodie's abscess. Such a lesion is often not accompanied by much pain; there is no nocturnal predominance and there is a tendency to the formation of a sinus.

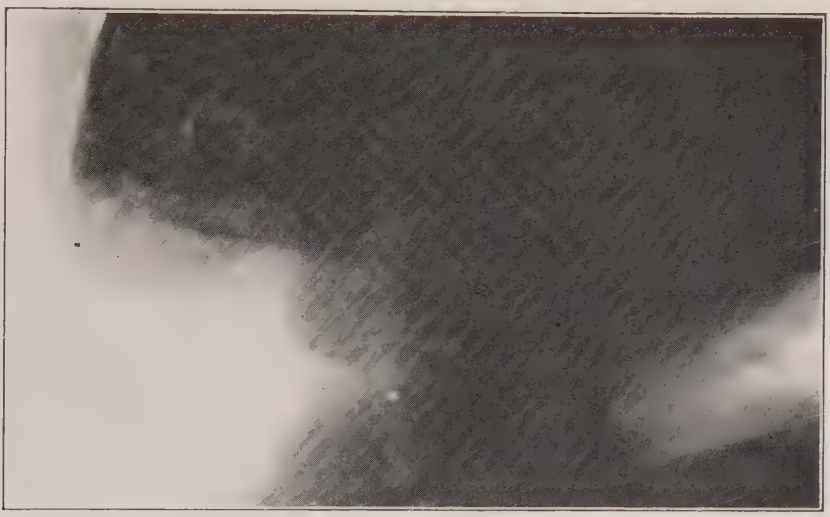

Fig. 91.—Tuberculous Osteomyelitis of the Mandible, Child Two and a Half Years Old.

Preoperative diagnosis bone cyst.

In the phalanges, the metacarpal and metatarsal bones the clinical and Roentgen ray picture of tuberculosis may be difficult or impossible to differentiate from syphilitic or pyogenic osteomyelitis.

## OSGOOD-SCHLATTER'S DISEASE

Certain tender swellings in the region of the epiphyses accompanied, at times, with serous joint effusion of greater or less extent, have been attributed to attenuated forms of bone infection. Probably related to this type are those manifestations in the posterior portion of the os calcis, in the greater trochanter and, above all, in the anterior tibial tubercle where the condition is known as Osgood-Schlatter's disease. Whether this last is the result of injury or is the result of a combination of injury and mild infection, is a question. In any event, usually after a blow or sudden movement, there is pain and swelling about the tibial tubercle. This occurs usually in boys at the ages of twelve to fourteen. A roentgenogram shows an irregularity and apparent slight displacement of the tubercle. By strapping or, in the severe cases, immobilization of the knee, there is rapid improvement and the condition improves to recur possibly, at intervals, if the exciting

Fig. 92.—Osgood-Schlatter's Disease in Fourteen-Year-Old Boy.

cause occurs again. The ultimate outlook is excellent and the suggested pegging of the bone in severe cases must be very rarely if ever necessary.

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## CHAPTER XIII

## DISEASES OF JOINTS

In childhood any joint may be involved, but those of the extremities are the most common sites of pathological processes. Those joints possessing the greatest range of motion, those which are weight-bearing and those which are most exposed to injury are the ones most frequently affected.

Synovitis is the term applied when the process is limited to the synovial membrane. When the articular cartilage is involved arthritis is the correct term.

### TRAUMATIC SYNOVITIS

Traumatic synovitis is frequently met with in children and it is worthy of note that a very slight trauma may result in definite evidence of joint involvement. The fact that not infrequently there has been a preceding nasopharyngitis or other upper respiratory infection renders it not unlikely that in some cases the element of infection has a bearing on the clinical manifestations.

**Pathology.**—As a result of trauma, a fall or wrench, there is congestion of the synovial membrane, a serous exudate and possibly fibrinous deposits. This fluid may rapidly disappear or may remain, distending the joint, with resulting stretching of the ligaments and capsule.

**Clinical Features.**—Involvement of the hip is most frequent and most confusing, and the clinical features of synovitis of that joint will be taken as a type. The condition is most frequent under ten years. Some days or even immediately after an injury, there is complaint of pain in one thigh and an evident limp. The discomfort is relieved by rest except in the severe cases with much swelling and there is rarely any general reaction. The limb is held flexed and often there is fullness and tenderness in the groin. Lateral pressure on the great trochanter is not painful. Careful and gentle examination will reveal that there is restriction in all the movements of the joint. A roentgenogram excludes bone injury.

**Diagnosis.**—The sudden onset of symptoms in a single joint, the relation to trauma, and, above all, the ready response to treatment serve to distinguish the condition. Tuberculous disease of the hip in its early stages may be confused with this condition. The early stages of a mild type of infective synovitis may be difficult to distinguish. Rheumatic arthritis gives less difficulty in diagnosis.

**Treatment.**—Continuous rest in bed and the application of a well fitting light elastic spica bandage to the affected hip are usually all that is required. The treatment should be kept up for from two to four weeks depending upon the severity of the symptoms. Rarely the effusion into the joint progresses, in which case aspiration is indicated with subsequent elastic compression. Occasionally light traction is necessary. As a rule the outlook is good but it must be remembered that a joint once involved is susceptible to a recurrence of the condition after injury.

## ACUTE INFECTIVE SYNOVITIS AND ARTHRITIS

At any time from shortly after birth to the end of childhood acute infections of the joints may occur. The vascular supply of the joints is rich, there are extensive vascular anastomoses in the tissues and intimate connection of the vessels of the joints with those of the adjacent bones. These facts are of importance in explaining the ease with which infection extends from bone to joint or from joint to bone. Infection may result through implantation from the surface of the body as a result of trauma, by direct extension from a neighboring focus or by way of the lymph stream. It is, however, far more frequent for infection to occur from the blood stream, as is the case in affections of the bone. While there is probably always a focal lesion it may not be demonstrable. The nasopharyngeal mucous membrane, local skin infections, otitis media and the umbilicus are frequent sources of infection. The organisms found are, in order of frequency, the streptococcus, pneumococcus and staphylococcus. Occasionally the gonococcus may be found in the newly born following ophthalmia, and in older girls following vaginitis. A joint infection following pneumonia is not invariably caused by the pneumococcus; frequently a streptococcus may be found in the joint fluid.

**Pathology.**—The process varies with the different organisms and even the same organisms vary greatly in virulence. In general there is first congestion of the synovial membrane, then exudate of fluid at first serous and later purulent. As the inflammation progresses there is formation of granulation tissue which replaces the synovial membrane. If the process is not arrested the granulation tissue infiltrates the articular cartilage eroding its margin and even stripping it from the underlying bone. The bare ends of the bone may become involved with a resultant slowly advancing osteomyelitis. If the infection is relieved before there is great damage to the synovial membrane complete restoration of the joint may result. When there has been much granulation tissue, more or less ankylosis may be expected. Bony ankylosis may follow when the bone itself has become involved. As in infection of bone there is a very wide variation in the

clinical manifestations, depending not only on the type of the infecting organism and its virulence, but also on the age and resistance of the patient. Infection by the streptococcus may be of two types, relatively mild or very severe and even fulminating with termination by death in a short period. The pneumococcus infection is probably the mildest and has the greatest tendency to spontaneous resolution. The staphylococcus infection is less severe than the worst form of streptococcus involvement. In the former, however, there is a greater tendency to bone destruction with resulting impaired function.

**Clinical Features.**—The chief symptom is pain, usually coming on suddenly, though the onset may be insidious with gradual development of disability. All motions are painful, the child guards the affected joint and holds it in the flexed position. The joint itself is swollen, its outlines obscured, the skin is hot and may be reddened and there is usually exquisite tenderness. Fluid in the joint may usually be detected and the overlying skin is often edematous. The general reaction depends upon the type of infection. There is always a greater or less degree of fever and leukocytosis. A roentgenogram may, after the first few days, give information of value. Particularly in the hip, knee and elbow the bone may be the site of the primary involvement. More than one joint may be affected.

Certain infectious diseases, notably scarlet fever, are complicated by inflammatory joint lesions. There may be merely a serous exudate without the formation of pus which more or less slowly tends to resolution. There may, on the other hand, be a purulent arthritis with relatively little local evidence.

**Diagnosis.**—Traumatic synovitis is differentiated by the history and prompt response to treatment. The character of the fluid withdrawn by aspiration, its microscopical examination, culture and the result of animal inoculation serve to distinguish tuberculous involvement. Scurvy, syphilitic epiphysitis and bleeder's joint will usually be easily distinguished by their own characteristics and the absence of general reaction.

**Treatment.**—The first indication is to put the joint at rest. This may be achieved in the case of the knee and ankle by a molded splint or by a Thomas knee splint. When the knee is involved it may be suspended in a Thomas splint and extension obtained through traction straps. When the hip is involved a Jones abduction frame is probably the best means of immobilization. If this is not available extension by means of traction straps in a position of slight flexion and abduction is indicated. The shoulder joint is best maintained in a position of abduction with either a Thomas or a Jones splint. When the elbow joint is the site of the infection the best position is a right angle. The wrist joint should be immobilized with the hand extended in a "cock up" splint. In the early stages hot applications

and the usual general measures are indicated. As soon as fluid is perceptible within the joint aspiration is indicated and as much fluid as possible is withdrawn. If one of the less virulent organisms is present, determined by the general reaction of the patient, the local condition of the joint and the morphology of the organism in direct smear, nothing further should be

Fig. 93.—Acute Suppurative Arthritis, Left Shoulder, Infant Six Months Old.

done. Subsequent aspirations are carried out as indicated and if the local condition improves gentle massage is instituted. When aspiration fails, or there is evidence of a severe infection, the joint should be opened, its cavity emptied by means of suction and then washed out with sterile physiologic salt solution, great care being exercised to avoid trauma to the synovial membrane. A rubber-dam drain should be introduced to the capsule of the joint but not into the cavity. Hot wet dressings of boric acid solution are

frequently renewed. Active and passive motion from the beginning have been advocated when there is reason to believe that the cartilage and bone are not involved. In exceptional instances this form of treatment may be of value but is rarely applicable in children. After the acute inflammatory symptoms have subsided massage and active and passive motion must be provided for.

*The Hip.*—Approach to this joint is either from the front or through the buttock. The joint cavity may be entered with a needle directed upward and inward from the middle of the posterior border of the greater trochanter. Very frequently the head of the bone is involved and eventually it may be necessary to remove it after division of the femoral neck.

*Knee-Joint.*—An exploring needle may be introduced obliquely into the joint from either the lateral or medial aspect of the patella. When arthrotomy is necessary an incision is made on either side of the patella. If posterior drainage is necessary on account of the progression of the infective process, an artery forceps may be introduced through the anterior incision until the end of the forceps is felt in the posterior pouch. No drains should be inserted. In exceptional cases the immediate use of active and passive motion is possible even in children and finds its chief indication in the treatment of infections of this joint.

*Ankle.*—This joint may be aspirated by a needle inserted below either malleolus. Incision is best made over the lower end of the tibia midway between the malleoli.

*Shoulder.*—Access to this joint may be either anteriorly between the pectoral and the deltoid or laterally through the fibers of the deltoid.

*Elbow.*—Approach is through an incision just over the radial head.

*Wrist.*—The joint is drained by an incision just below the ulna.

**Prognosis.**—Prognosis depends upon the stage at which diagnosis is made, the type of the infecting organism and its virulence. Early incision, the avoidance of any drainage material within the joint, followed when the active inflammatory symptoms have subsided by massage and active and passive motion, give the best outlook for a good joint.

**Peculiarities of Arthritis in Infants.**—This condition often attacks infants in the first month and the umbilicus is usually the infecting focus. Almost always the process originates in a bone lesion. Many joints are often involved. There may be relatively little local reaction. While in the general hospital group the mortality is approximately 50 per cent, in the instances occurring in well-cared-for, well-nourished infants, the outlook is much better. As far as the local condition is concerned the prognosis is fairly good. There is not usually great bone destruction. The general treatment is very important and transfusion of blood is often indicated. Locally an incision should be made when there is evidence of fluid. No drainage ma-

terial is introduced and passive motion is begun immediately. It is probably never desirable to curette the involved bone. If the process does not rapidly clear up and there is evidence of much bone destruction, the joint should be immobilized in that position which gives the best function if ankylosis occurs.

Fig. 94.—Arthritis of the Left Hip in an Infant Eight Months Old.

## HEMOPHILIC OR BLEEDER'S JOINT

Joint effusions occur in bleeders of all ages but are most common in boys. The affection may occur in one or more of the larger joints of the body but the knee-joint is most frequently involved. After some trivial injury or even without apparent cause, a hemorrhage takes place into the joint. There is swelling of the joint, which cannot be completely extended, and pain, often sufficient to confine the patient to bed. There is ecchymosis and the temperature is often elevated. With rest and treatment the blood in the joint is slowly absorbed and by the end of two or more weeks the symptoms may disappear. As a rule these attacks are repeated, they become less painful but the joint becomes the seat of permanent changes and has a characteristic doughy feel. Synovial thickening, deposits of fibrin, extensive adhesions and sometimes erosion of the cartilage terminating in ankylosis are found.

As the swelling of the joint is associated with atrophy of the muscles, muscular spasm and flexion, the condition may be confused with tuberculous disease. Such an error may have disastrous results if an operation is undertaken. History of a family tendency to hemorrhage is an important aid in diagnosis. Treatment of a recent hemorrhage consists in securing absolute rest and applying elastic compression. Aspiration is definitely contra-indicated. Transfusion, or failing this, the intravenous or subcutaneous injection of 10 to 15 c.c. of blood-serum may assist in arresting the hemorrhage. After the acute symptoms have subsided massage and passive motion should be instituted to promote the absorption of blood and the restoration of joint function.

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## CHAPTER XIV

## SURGERY OF THE HEAD

### CONGENITAL MALFORMATIONS

*Cephalocele* is a term applied to a protrusion of a portion of the cranial contents through a congenital defect in the skull and is due to an irregu-

Fig. 95.—Small Encephalocele, Infant Four Months Old.

larity in development whereby a portion of the cerebral vesicle remained outside of the cranium. The protrusion is covered by scalp and is most commonly met with in the occipital region or at the root of the nose. Rarely the tumor is situated at the base of the skull and projects into the nose or pharynx where it may be mistaken for a polypus. There is great variation

in size, and hydrocephalus, spina bifida or other deformities may be associated. There are several varieties.

*Meningocele* is a protrusion involving the meninges only and containing spinal fluid.

*Encephalocele* is characterized by the presence of brain substances in addition.

*Hydro-encephalocele* is the variety in which the protrusion includes a portion of the ventricle.

**Clinical Features.**—The meningocele is most frequently found in the occipital region. It forms a tense, smooth, globular swelling which may be sessile or pedunculated. The covering is often thin and parchmentlike and the opening in the bone may be made out. There is increase in tension when the child cries. It is unwise to attempt to diminish the size by pressure as this may cause alarming symptoms. Small meningoceles may not increase in size and may rarely undergo spontaneous cure. Encephaloceles are more common, vary greatly in size, are elastic and may pulsate. They may be found either in the frontal or occipital regions. Hydro-encephaloceles occur usually in the occipital region and are often so large as to be incompatible with life.

**Diagnosis.**—The various forms of cephalocele are to be distinguished from dermoid cysts, angiomata, cephalhydrocele and cephalematoma. If the margins of the gap in the skull cannot be made out a roentgenogram is often of service.

**Treatment.**—Only the smaller tumors are amenable to treatment. The immediate result of the operation is often good but, as in spina bifida, hydrocephalus usually develops. A small meningocele, in the occipital region, if covered by normal scalp, is best not operated on.

## THE SCALP

**Birth Injuries.**—The most important birth injuries are cephalematoma, intracranial hemorrhage and, more rarely, fracture of the skull.

*Cephalematoma* is an encysted extravasation of blood between the bones of the cranium and the periosteum occurring in newborn children. It is usually limited to one bone, most frequently the right parietal, but occasionally the extravasation passes across the midline to the opposite side. The condition is seldom present at birth but appears two or three days later as a soft fluctuant tumor, with no discoloration of the skin, and increases in size for several days. Shortly a bony ridge is developed about the circumference of the tumor which contrasts with the central soft portion. Subsequently a thin layer of bone may extend over the whole surface and produce an "egg-shell crackling" on palpation. The mass gradually becomes smaller and

after a considerable time is absorbed, leaving behind a bony ridge which, in turn, after a longer time, disappears. The condition is occasionally complicated by intracranial hemorrhage.

Diagnosis is usually easy if the possibility of the condition is kept in mind. To be distinguished are:

Caput succedaneum, which is a subcutaneous serous infiltration of that portion of the scalp corresponding to the center of the birth canal. The swelling is diffuse, not limited to one bone, is firm and doughy and tends to disappear in a few days.

Depressed fracture of the skull, which may be differentiated by the fact that the hematoma is all above the level of the bones and the firm edge may be indented.

Cephalhydrocele, which occurs rarely as a result of fracture of the vault complicated by rupture of the dura. A fluctuant swelling develops which varies in size and may be partly reduced by pressure.

Ordinarily treatment is limited to protection and careful cleansing of the skin. Any wounds in the overlying skin should be carefully dressed. Pressure is of no avail and aspiration is not indicated in the ordinary cases. In the event of infection a small incision should be made.

*Intracranial birth hemorrhage* has been discussed in Volume V of this series. The hemorrhage is more frequently diffuse than localized and this fact seems to me to contra-indicate surgical interference except in those rare cases in which the clinical signs and symptoms point definitely to a local cortical effusion of blood. I have had no personal experience with the operative treatment of this condition.

Following application of obstetrical forceps there may be *laceration of the scalp*. As these wounds are the result of pressure there is frequently rather widespread sloughing. Treatment consists in careful daily dressing.

*Facial paralysis* from injury to the facial nerve is usually temporary.

*Ordinary bruises and wounds* of the scalp differ little if at all from similar conditions in adults. In any such wound it is important to consider carefully the character of the violence, as injury of the bone may be associated without obvious symptoms. The wound itself should be carefully examined and if there is any suspicion of a complicating fracture a roentgenogram should be made. A clean-cut wound may be cleansed and sutured. If there is laceration or gross contamination careful débridement is indicated.

*Hematomata.*—A severe contusion may result in a subperiosteal hematoma which, from its raised edges and soft apparently depressed center, may simulate a depressed fracture. The fact that the edge may be indented and a negative roentgenogram serve to distinguish the condition. A slight

blow on the head in a hemophiliac may result in a hematoma, lifting practically the entire scalp from the underlying skull. The treatment of such hematomata should be conservative and involves chiefly protection and cleanliness of the skin. Aspiration is rarely indicated in any case and is definitely contra-indicated in hemophiliacs. If infection supervenes an incision of sufficient extent to permit evacuation of the clots should be made.

*Avulsion.*—Complete avulsion of the scalp is not uncommon in children. Where the avulsion is partial and sufficient attachment remains to provide circulation the flap may be replaced after careful cleansing with a reasonable hope of union. When a portion of the pericranium is torn free and

Fig. 96.—Extensive Sloughing of Scalp Following Infection in an Infant.

the bone is bared the superficial layer of bone will usually exfoliate before the granulating area may be skin-grafted. The boring of holes through the cortex into the diploë has been advised in adults to hasten granulation. As the skull is thin in children and the diploë largely absent, this is dangerous and unnecessary.

**Furuncles and Cellulitis.**—Infection of the scalp manifesting itself in furuncles or cellulitis is common in infants, particularly where nutrition is poor and in long-continued illness. Prophylaxis consisting in cleanliness and the avoidance of pressure is important. When furuncles appear the skin should be cleansed daily with a bland soap and water, dried, sponged with alcohol and a thin film of 1 or 2 per cent ammoniated mercury ointment applied. Sometimes sponging the area with a weak permanganate solution is of value. When the furuncle softens the pus is evacuated through a small incision with a sharp knife. No gauze packing or rubber drainage

is desirable. Heliotherapy is of value in this connection. An extensive and rapidly spreading cellulitis may occur. Moist dressings of 10 per cent alcohol should be applied. When fluctuation appears incision is made in those areas which afford best gravity drainage. Several small incisions are

FIG. 97.—DERMOID CYST OF SCALP, REGION OF ANTERIOR FONTANEL, INFANT TEN MONTHS OLD.

preferable to one long incision. As in all infections in infants, the maintenance of nutrition is of prime importance. Occasionally transfusion of blood seems to be the turning point in establishing convalescence.

Erysipelas is not infrequent and in this situation is particularly hard to diagnose. Pain is more marked than elsewhere and the constitutional symptoms may afford the clew to a diagnosis. The characteristic redness and line of demarcation are often not apparent until the hair line is passed. Recovery

occurs more frequently than might be expected from the severity of the general reaction. There is no specific treatment and cold compresses are the best local measure.

**Cysts and Tumors.**—Dermoid cysts may occur and often resemble sebaceous cysts or wens, which latter are exceptional in this situation in

Fig. 98.—Local Result Following Compound Depressed Fracture of Skull. Case referred to in text.

children. Dermoids are usually single and often situated in the region of the anterior fontanel. They are deep seated and may cause erosion or even disappearance of the underlying bone. Their removal is indicated as soon as the condition of the child warrants it.

Nevi occur on the scalp and have the same characteristics as elsewhere. It is important to remember, however, that occasionally a similar condition occurs within the skull and may cause focal symptoms.

Benign tumors, lipoma and fibroma, are rare.

The malignant tumors are practically confined to metastatic bone involvement, often from tumors of the adrenal.

Arterial angioma or cirsoid aneurysm is a tumor composed of the enlarged branches of an arterial trunk. The origin of this condition is probably congenital though it frequently follows an injury. It practically always occurs in the scalp and often involves the branches of the temporal artery. The condition is evidenced by a swelling containing tortuous, pulsating vessels. The vessels composing the swelling are likely to increase in size. There is associated a constant bruit which may become so marked as to interfere with sleep. Severe hemorrhage may follow a trivial wound. There is no tendency to spontaneous cure and the condition is often resistant to all forms of treatment. Excision is the most successful but often proves to be a formidable procedure. Where excision appears impossible electrolysis may be tried.

Pneumatocele—a collection of air under the periosteum—is rare and results from inflammatory or traumatic destruction of the cortex over air containing cells. Treatment consists in incision and packing to cause healing by granulation.

## FRACTURES OF THE SKULL

**General Consideration.**—The great changes which take place in the constitution of the skull and its contents from infancy to adult life have an important bearing on the result of injury at different periods of growth. At first, composed of separate segments of partially ossified membrane and cartilage, loosely held together, the skull is capable of being easily molded. Subsequently there ensue various stages in which elasticity yields to hardness and the cranium is converted into a hard and brittle container. The brain and membranes also undergo a remarkable change in consistency and development of structure. In infancy and early childhood the bones of the vault are thin and flexible and the application of force results in bending rather than breaking. The presence of the intersutural membranes limits the transmission of force from one area to another. The dura is closely adherent to the bone and at the suture lines and more liable to damage. This same peculiarity, however, tends to limit the extent of the extradural hemorrhage.

**Birth Fractures.**—Fracture of the skull is relatively rare as a birth injury. Indented fracture of the vault may be produced as a result of pressure either from the sacral promontory of the mother or from the obstetric forceps. The injury is most often seen in the frontal or parietal region and the amount of depression varies considerably. The fracture is not complete and is quite analogous to the greenstick fracture in long

bones. An indentation in a thin-walled celluloid ball has a similar appearance. It is exceptional for the condition to be complicated by intracranial hemorrhage and there is usually an entire absence of symptoms. Fissure fracture of the cranial bones may occur with or without displacement of the fragments.

**Diagnosis.**—Diagnosis is usually easy unless there is an overlying extravasation of blood. A roentgenogram is indicated in all suspected cases.

**Treatment.**—There is a definite tendency for spontaneous elevation in the slighter degrees of the condition. If there is marked depression treatment should be instituted at once. Pressure on the surrounding parts may cause elevation. The point of a volsellum blade may be introduced through the bone at the depth of the depression and elevation effected. If the depression has not been corrected at birth and there is no tendency to spontaneous elevation, a narrow periosteal elevator is introduced through a small incision at the edge of the depression and the bone elevated.

Contrary to the usual opinion, fractures of the skull are not infrequent in childhood, and probably as many fractures occur in the first decade as in any other. While the injury which results in fracture is often of considerable degree, an apparently trivial injury may result in fracture of the vault. Such fractures may be easily overlooked as they may be attended by few or no symptoms and are only revealed by means of a roentgenogram. Fortunately at this time of life the injury is apt to be less severe as well as less extensive than in adult life. The prognosis is better and the mortality is probably lower than at any other period.

**Etiology.**—Falling downstairs, roller skating and other sports and games of childhood offer endless possibilities of injury. The automobile is an important factor in producing skull injuries and fractures sustained in this way are usually serious and are often associated with other severe injuries.

**Pathology.**—As in the adult, fractures of the skull may be divided into:

1. Fractures of the vault—linear or depressed
2. Fractures of the base
3. Combination of the two

Fracture of the vault is the most common type. The fracture line may be confined to one bone or may be very extensive with several lines of fracture extending in different directions. The very extent of the injury may result in a natural decompression if the dura is torn. As a result of fracture of the frontal bone air may enter the cranial cavity and what is known as an intracranial aërocele result. Any fracture may be associated with an intracranial complication such as hemorrhage, cerebral edema, laceration or contusion of the brain. The effects of violence on the brain resemble those

produced in adults. The elasticity of the vessels in the child tend, somewhat, to limit the extent of the hemorrhage, and extradural hemorrhage is further limited by the adherence of the dura to the skull. There is a greater tendency to edema of the brain which is, however, compensated for by the greater distensibility of the cranium. The power of full recovery is striking. There is not the same tendency to involve the base as in the adult. Basal fractures indeed are uncommon in children and as such a condition usually results from the more severe injuries, the more extensive forms of intracranial injury often occur as complications.

In fractures of the base, hemorrhage from the ear, nose or mouth or subconjunctival ecchymosis may occur. Ecchymosis in the mastoid region appearing one or more days after the injury is suggestive of fracture into the middle fossa. Escape of cerebrospinal fluid and even of brain tissue from the nose or ear has been noted but is unusual. Cranial nerve injury is not uncommon. Infective complications such as meningitis, sinus thrombosis or brain abscess may occur when the fracture is compounded by opening into the nose, pharynx or ear. Such complications are less common than might be expected.

**Clinical Features.**—Injuries of the cranium and injuries of the brain cannot be considered separately in their clinical aspects. It is rare indeed that one is seriously injured without the other suffering to a greater or less extent. Sometimes the brain is severely injured while the injury to the skull is apparently slight. It is rare, however, for there to be a serious injury to the bone without a definite lesion of the brain. There does occur in childhood, and probably more frequently than is realized, a linear fracture of the vault with little or no evidence of associated brain injury, often as the result of apparently trivial injury. This type of fracture is only revealed by the routine use of roentgenography. Occasionally a severe injury involving both the cranium and its contents may occur and be overlooked on account of the absence of symptoms, as the following case will illustrate:

A boy of nine was struck on the head by a stone and knocked unconscious. He was carried to a neighboring hospital, regained consciousness immediately and then walked two blocks to his home. There was much swelling in the region of the blow and twenty-four hours later on his second visit to the hospital an incision was made and a drain inserted. Five days later a second incision was made. Thereafter the wound was dressed at intervals, there was free drainage of pus and no other symptoms except some slight loss of weight. One month after the original injury he was admitted to St. Luke's Hospital. At that time there was a dirty, granulating wound in the left frontoparietal region and the temperature was 103°. A roentgenogram revealed an irregular, depressed fracture of the skull with several pointed fragments which it seemed, from their position, must

have penetrated the dura. There was also a fracture line which appeared to extend into the base of the skull. After careful consideration it was deemed inadvisable to attempt to elevate the depressed fragments in the presence of so much infection. The wound was cleansed, the granulations gently curetted away and the overhanging edge of the outer table at one side was cut away with rongeurs. Thereafter intermittent irrigation of the wound with Dakin's solution after the method of Carrel was instituted. The

Fig. 99.—Hematoma of Scalp in Hemophilic Boy Twelve Years Old.

temperature soon became normal and the wound rapidly healed. He was discharged from the hospital and returned for the second operation which was carried out five months after the original injury. At this operation the depressed fragments were elevated and removed and it was obvious that several had penetrated the dura into the brain substance. His convalescence was uneventful and he has been seen at intervals in the follow-up clinic during a period of five years. He has developed normally and has never had any symptoms referable to his injury.

It is the injury to the contents of the skull rather than to the skull itself which lends importance to the condition. The fracture is evidenced by pain and swelling and possibly deformity. The intracranial injury may

result in (1) cerebral shock or concussion, (2) cerebral irritation, (3) compression of the brain. These conditions should not be considered as independent entities but as overlapping and merging into one another. Furthermore, cases are frequently met with that do not run the course characteristic of any of these groups.

**Cerebral Shock or Concussion.**—Shock or concussion is present to some extent in every child who receives a blow upon the head. In the slighter cases there is no loss of consciousness but merely a feeling of faintness or giddiness for a few minutes. Recovery is rapid, not infrequently attended by vomiting, and the child shortly feels quite well again. Where the injury is quite severe there is immediate unconsciousness. In some instances there is a tetanic seizure associated with arrest of respiration. The skin is cold and clammy, temperature subnormal, pupils dilated and with sluggish reaction to light. The respiration is slow and shallow, pulse is slow, small and weak and often irregular and the blood-pressure is low. While the child may be aroused by external stimulation he quickly relapses into unconsciousness. Voluntary movements and the deep reflexes are abolished but there is no true paralysis. After a period varying from a few minutes to several hours there is a beginning return to consciousness. Vomiting may occur, respiration is deeper and the pulse stronger. The face becomes flushed, the body warm and motion returns. After the first two or three months of life, the younger the child the more unstable the nervous system. On this account convulsions and varying degrees of irritability may be expected more frequently in childhood. Sometimes the child is very fretful in the period of convalescence following concussion, sometimes he may sleep a great deal. As a general rule recovery is complete and there is relatively little tendency to the occurrence of the unfortunate after effects so often noted in adults. When there is associated gross brain injury the condition described above may merge into cerebral irritation.

**Cerebral Irritation.**—In this phase the patient assumes a state of general flexion, he is often restless and tosses about the bed. The pulse is slow and feeble and the skin cold. If an attempt is made to arouse him the child shows evidence of irritability. When the temperature is high it may be assumed that there has been more or less cerebral laceration. In favorable cases there is a gradual return to health. When as a result of hemorrhage or edema the contents of the cranial cavity are increased the symptoms of cerebral compression appear.

**Cerebral Compression.**—There must be a considerable increase in the contents of the cranial cavity or the cavity itself must be decreased materially in size by depression of its walls before symptoms appear. It is very unusual for depression of bone without cerebral injury to result in symptoms of compression. The only fluids in the brain are the cerebrospinal

fluid in the ventricles and the blood in the vessels. When from edema of the brain or as a result of hemorrhage more room is needed in the cranium, the only way to obtain it other than by enlarging the cavity is to force out the fluids. Room is gained at first by displacement into the vertebral canal of a certain amount of cerebrospinal fluid. The capacity of the spinal sheath is small and shortly room is gained at the expense of blood in the vessels. As there is no vasomotor control of the cerebral vessels the only way to get more blood in a given region is to increase the rate of flow. As a result of increase in the intracranial pressure from edema or hemorrhage the blood-vessels become compressed, leading to anemia, which, in turn, stimulates the centers in the medulla which control the circulation and as a result more blood is directed to these centers through a rise in blood-pressure. In a majority of cases the symptoms of compression supervene on those of shock. In certain conditions, notably the classical one of hemorrhage from the middle meningeal artery, there is a free interval of complete consciousness after the symptoms of concussion have largely disappeared. In others there is no free period and the symptoms of concussion gradually merge into those of compression. The course of the symptoms and the rapidity of onset vary according to the extent of the brain injury. Death may occur promptly or recovery may ensue after several weeks of unconsciousness. At first the symptoms are irritative, pain in the head, dizziness, restlessness, and hypersensitiveness. The face is flushed, temperature falls and vomiting occurs. As the condition progresses dilatation of the veins of the scalp and particularly those of the eyelids is noted. Consciousness is gradually lost —the pulse becomes slow, full and bounding, the respiration varies in depth and rhythm and may become typically Cheyne-Stokes in character. It is not usual for the respiration to assume, in children, the stertorous character so frequently observed in adults. After a preliminary fall in temperature, it rises and if it attains to 104° or higher the outlook is poor. There may be retention of urine and involuntary defecation. Direct involvement of cortical centers may be evidenced by focal symptoms. There is a progressive rise in blood-pressure. There is such variation in the pupils that their condition is of little diagnostic value. The ophthalmoscope reveals distended and tortuous vessels in the papilla. While the patient may remain in this stage for a long time and recover, it must be understood that the medullary centers may become exhausted at any moment and death ensue from respiratory paralysis. The margin of safety is much less in children than in adults.

**Infection.**—Symptoms somewhat similar to those described above may occur as a result of infection with meningitis or abscess formation.

**Diagnosis.**—The diagnosis of a fractured skull is important even though there is no evidence of cerebral injury, if only from the standpoint of

treatment. The condition may be obvious or suspected from the physical examination. A roentgenogram will afford definite evidence and should be made in every instance. In exploring a wound of the scalp a fracture line, with or without depression, may be made out. The suture lines are often confusing and it is sometimes of use to remember that a fracture line may bleed while a suture never does. The presence and degree of intracranial injury is determined, to some extent, by immediate examination, but in most instances chiefly by watching the changing train of symptoms. Lumbar puncture combined with the use of a spinal manometer is of value in determining the presence of intracranial pressure. If graduated in centimeters of water a pressure of over 10 centimeters is considered pathological as is that of over 10 millimeters if the instrument is graduated in millimeters of mercury. Examination of the fundus of the eye by means of the ophthalmoscope affords evidence of the condition of the disk, dilatation of the vessels, blurring of the margins or choked disk, all indication of varying degrees of increased intracranial pressure. Repeated observations of the pulse rate and of the blood-pressure often afford information of great value.

*Differential Diagnosis.*—There are many conditions in the adult associated with unconsciousness which may be mistaken for the unconsciousness of cerebral injury. This is not true in children and there is little likelihood of confusion. In complicated injuries with severe shock it may be difficult to decide how much influence the cranial lesion has on the general condition. Diabetic and uremic coma, while unusual, do occur in children; each may be distinguished by examination of blood and urine.

**Prognosis.**—The prognosis depends on the nature and extent of the brain injury and it is difficult to formulate any general statements. A rapid rise of temperature to or above 104° is a very bad sign. Persistent deep coma and repeated convulsions indicate a serious condition. In general the outlook as to recovery in children is much better than it is in adults. In the event of survival there is also less likelihood of the development of sequelæ. This is particularly true of so-called traumatic neurasthenia and less true of traumatic epilepsy.

**Treatment.**—If the child comes under observation shortly after the injury, shock is probably present. At this time no other treatment than that directed to the relief of shock is permissible with the exception of the application of a sterile dressing to any wound which may be present. The child is placed in bed with the head slightly elevated and warmth applied by means of hot blankets and carefully protected hot-water bottles. If necessary small doses of codein may be given. If stimulation is indicated a hypodermic of camphor in oil may be of value. At this time constant observation is essential with half-hourly written records of pulse and respi-

ration. A careful watch is kept of the state of consciousness and the advent of neurological signs. Under no circumstances should active treatment of any sort be instituted during the period of shock. When shock has begun to lessen and the general condition appears fair a thorough examination may be made. If no operative interference is indicated little treatment other than general care is necessary. Bromids may be administered if indicated. In fractures of the base many surgeons advise the routine administration of urotropin for several days. Catheterization and enemata are employed when needed. If sufficient fluids are not taken they may be supplemented by rectal injection or hypodermoclyses. The necessity for prolonged mental and physical rest is just as great in children convalescing from cranio-cerebral injuries as it is in adults.

## LOCAL INJURIES

All wounds of the scalp should be cleansed after a suitable area has been shaved, débridement done if necessary, the skull surface explored and the edges of the wound approximated with sutures. Operation is indicated as soon as the patient's condition warrants in compound fractures, sharply depressed fractures and when there is evidence of intracranial hemorrhage. In fractures of the base, careful attention to the condition of the nose, ears and mouth is essential. Irrigation is not indicated. Where there is communication with the nasopharynx treatment is limited to cleansing the nares and the use of a mild antiseptic mouth wash. Where there is communication with the auditory canal this is cleansed of blood, the canal painted with weak iodin and a small piece of sterile cotton placed in the meatus. If there is profuse discharge of fluid it is probably better to apply a loose gauze dressing which should be changed frequently. When there is increased intracranial pressure various methods of treatment have been used. Of the dehydrating fluids a concentrated solution of magnesium sulphate by rectum is probably the most efficacious and least harmful. Repeated lumbar puncture may prove of considerable value. In cases of increased intracranial pressure of moderate degree where, following one or more punctures, signs of pressure diminish, punctures are done at intervals until the pressure is approximately normal. The possibility of jamming of the medulla into the foramen magnum as a result of the sudden release of tension has been stressed by some who consider ventricular puncture as safer. When the site of a hemorrhage producing continued and increasing intracranial pressure can be made out the area is exposed through a trephine and the bleeding arrested. When the site of the hemorrhage is not known and in spite of the various methods the pressure is increasing or remains high, a subtemporal decompression is indicated on

the right side in right-handed individuals and on the left side in the left-handed. A wise conservatism should be exercised in the treatment of all cerebral injuries in children. The necessity of operative intervention for the relief of intracranial pressure is relatively infrequent.

Brain tumors and hydrocephalus have been discussed in Volume V of this series. I have had no personal experience with the operative treatment of these conditions and those interested are referred to special works on the subjects.

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## CHAPTER XV

## SURGERY OF THE FACE AND MOUTH

### CONGENITAL CLEFT LIP (HARELIP) AND CLEFT-PALATE

Cleft lip is a congenital notch or fissure in the upper lip, and cleft-palate is a defect in the roof of the mouth. Either of these conditions may exist alone, but they usually occur in combination and are among the more common congenital malformations. The incidence has been estimated as approximately one in twelve hundred births. The various defects, and the many combinations of them, are due to lack of fusion of the several processes which form the face.

The embryology of the deformity has been well summarized by Brophy:

"In the human embryo of about the third week, the face is in the process of development. From the front of the cephalic mass five tubercles bud out, of which the first, the premaxillary, passes vertically downward. The tubercle is double and forms the premaxillary bones in which the incisor teeth are developed. It therefore, bears the name 'incisor tubercle.' The rudimentary maxillary bones, which are widely separated, are developed at each side of the incisor tubercle, though not united with it; while the fourth and fifth tubercles which are separated in front, subsequently unite in the median line and form the mandible. Simultaneously the palate begins to be formed by the approach toward the median line of the two horizontal plates developing from the maxillary processes on either side. If the palatal processes of the maxillæ unite in the median line and blend also with the premaxilla and the vomer grows downward to meet the palatal processes in the line of union, the upper jaw and lip will be normal. By the beginning of the third month, the parts which enter into the formation of the palate should be united. If, however, the superior maxillary and premaxillary processes fail to unite with each other, cleft lip and palate, in one of their many forms, result."

Ritchie makes the following statements as a result of study of the embryology:

1. "The lip and the palate defect are not two separate entities but a failure in the same embryologic process of union."
2. "All tissues are present but out of contact."
3. "The clefts, once normally present, close from before backward."
4. "The palate bones normally unite by bony union."

The cleft of the lip varies in extent and may involve the vermilion border only or may extend into the other tissues. The upper lip is almost invariably the one affected. Very rarely there is observed a small cleft or a fistulous opening, in the center of the lower lip. Median harelip is the only variety which exactly resembles the normal lip of the hare and is exceedingly rare. The common condition is a lateral cleft, the result of incomplete fusion between the maxillary process and the incisor tubercle. The malformation may be single or double, depending on the involvement of one or both sides. The unilateral cleft forms 70 per cent of the total number. It is complete if the cleft extends into the nostril and incomplete if the nostril is not involved.

Associated with cleft lip, or independent of it, there may exist various forms of cleft-palate, varying from the minor defect of a bifid uvula to the extreme deformity of complete fissure of the hard and soft palate. The cleft may affect the soft palate alone or there may be a pure alveolar cleft occurring in combination with cleft lip.

Aside from the fact that all authors agree that heredity is a prominent factor in the production of cleft lip there is very little actually known as to the etiology. The theory of maternal impression having influence on the developmental defect is without foundation. Almost invariably the fright or other cause to which the condition is attributed occurs long after the beginning of the third month, the time of normal union of the parts.

Single cleft lip is about twice as common on the left as on the right side and occurs more frequently in boys than in girls. In the slighter degrees there may be no appreciable deformity of the nose. In other instances, even where the cleft is incomplete, there is a very thin area extending into the nostril which requires excision to secure a satisfactory result. Where the cleft is of any extent, however, and particularly in complete cleft with associated alveolar defect, there is considerable deformity, the nostril on the affected side is flattened and there is deviation of the nasal septum. This flattening and distortion of the nostril which is so disfiguring is largely due to the depression of the alveolus on the affected side.

If the cleft is incomplete there is little or no effect on the development of the child. If, however, there is a complete cleft, and particularly when the cleft is double and combined with cleft-palate, the child finds it difficult or impossible to suck and food introduced into the mouth tends to regurgitate through the nose. Such children are often poorly developed to begin with and the difficulties of feeding result in impaired nutrition. The inspired air is not heated and rhinitis and bronchitis are recurring complications. It is of course best for the child to nurse if he can. Where nursing

is impossible other means must be adopted. Brophy has devised a rubber velum, held in place with an aluminum handle, which closes the cleft while the child is nursing. A similar velum may be attached to the rubber nipple. If nursing and bottle feeding fail, resort must be had to a tube, spoon or medicine dropper.

Many of these unfortunate children are deficient in other respects and are unlikely to survive to adult life. A large proportion, however, have a fair chance and it devolves upon the practitioner and the surgeon to so direct the treatment that if the child does survive he will have the best cosmetic and functional result obtainable. Operative repair is the only method of treatment and should be undertaken as soon after birth as the baby's physical condition will permit. The only exception to this rule is in the case of an incomplete cleft of the lip without involvement of the alveolus, when the operation may be deferred until the latter part of the first year.

Fig. 100.—Incomplete Cleft of Lip.

The operative procedure is carried out in stages and the lip is repaired at the primary operation. Young infants stand operative procedures well and there is great advantage in operation before the third or fourth month while the bones are soft and pliable. At this period the premaxilla can more readily be molded into place and the edges of the cleft in the alveolus approximated. It is unwise to operate on a baby until the birth weight has been regained and there is in addition a progressive gain. Often operation is urged as a means of improving the baby's condition but in general it is better to persevere with medical measures until there is evident a steady gain in weight. If the baby is not on the breast he should at least be well established on artificial food before operation is contemplated. He should be accustomed to being fed with a medicine dropper or a spoon for a short period before the operation, as the nipple should not be used for two weeks after operation. From time to time liquid albolene should

Fig. 101.—Complete Unilateral Cleft of Lip.

Fig. 102.—Bilateral Complete Cleft of Lip with Complete Cleft of Palate.

be applied to the exposed mucous surfaces and every effort made to avoid irritation or abrasions. Precautions should be taken against contact with respiratory infections and if there is any indication of inflammation involving the mucous membranes culture from the nose and throat should be made. A roentgenogram of the chest excludes enlarged thymus. If the latter is discovered radiotherapy is indicated, otherwise, as soon as the birth weight is regained and the infant shows a steady gain, the first operation is done.

Fig. 103. Bilateral Complete Cleft of Lip with Complete Cleft of Palate, Infant Three Months Old.

If there is a cleft in the alveolus it is essential that this be repaired at the same time as the lip or by a previous operation. If this is not done there will result an unsightly deformity of the nostril due to the depression of the alveolus and consequent lack of support for the ala of the nose. While a lip repaired over a wide alveolar cleft will undoubtedly tend to bring the edges of the cleft into apposition, there remains some inequality in the two sides and a depression of the ala on the affected side, with its resultant wide and unsightly nostril. If the operation is performed while the bones are pliable the alveolar borders can be molded by pressure and held by a suture of silver wire, so introduced as to avoid the tooth follicles. A further step in restoring the contour of the affected nostril is the wide separation of the lip with the ala from its attachment to the maxilla. The early repair of the lip tends to a spontaneous narrowing of the cleft in the palate. Furthermore, the lip is placed in such a position that its development may proceed satisfactorily. Where there is a bilateral cleft of the lip the repair should be accomplished in two stages. At the first operation the malposition of the premaxilla is corrected and one side of the cleft in

the lip is repaired. Three or four weeks later the opposite side is operated on.

The repair of the lip is often relatively easy. It is the closure of the palatal clefts which furnishes the real problem. The time at which this procedure is undertaken is important. It is very desirable to have the defect repaired before speech is established. Some surgeons operate as early as six months in particularly favorable cases. In general the period from sixteen to twenty-four months is probably the best time. Under

Fig. 104.—Result Following Operation for Repair of Bilateral Cleft Lip.

favorable conditions the closure may be completed in one stage. In complete clefts, however, it is usually better to divide the procedure into two or more stages. As a rule it is better to operate first on the anterior end of the cleft, leaving the soft palate for a subsequent operation which should be postponed until the anterior portion is completely consolidated and the flaps well vascularized. It is essential to a good functional result that the soft palate be flexible and of sufficient length.

Various incisions have been described for use in the repair of the lip, and the use of calipers, as advised by Thompson, is of great aid in planning the incisions. In the repair of the palate a modified Langenbeck operation

utilizing a mucoperiosteal flap with edges pared and lateral releasing incisions is the method most generally used. Metal plates or flattened silver-wire tension sutures serve to support the suture line. In addition iodoform gauze is packed into the lateral incisions and aids in securing a good result. No attempt will be made to describe the technic of the various operations and those interested will find adequate descriptions in the references appended.

The after care is important. If there is shock as a result of the operation, which does not respond to heat and hypodermoclysis, a transfusion is indicated. For two weeks after operation feedings should be by spoon or medicine dropper. Hypodermoclysis of 3 per cent glucose in salt solution is given as often as necessary to ensure adequate fluid intake. The suture line is kept as clean as possible. After palate operation fluids only are given for the first five or six days. Some operators allow nothing but sterile fluids. For twenty-four to forty-eight hours only 5 per cent glucose solution is allowed. Following each feeding after this period the mouth is cleansed with a stream of warm sterile water. The suture line is inspected daily and any deposit on the sutures is removed. After the operation has been successfully completed it is essential that the child receive careful training in speech. This is usually best carried out by the mother under the instruction and supervision, if possible, of an expert and extends over a period of years. There is no step in the operation more important than this training in phonation. No matter how perfect the anatomical result may be, a good functional result is only obtained by long and painstaking training. In a large proportion of cleft-palate cases the eruption of the teeth is irregular and the occlusion poor. If the child is placed under the care of an orthodontist these defects may be greatly improved.

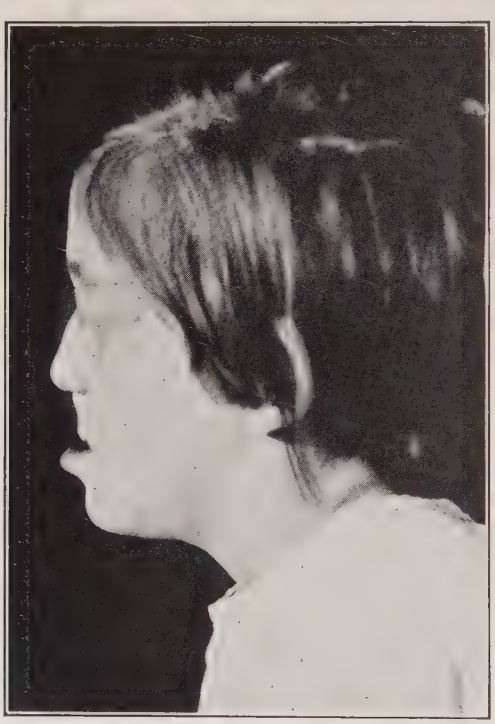

Fig. 105.—Unsightly Deformity Following Operation for Repair of Cleft Lip, Flattening of Upper Lip, Protrusion of Lower.

## CYSTS

Dermoid cysts not infrequently occur on the face in those situations which correspond to developmental clefts. The most frequent site is the region of the external angular process, less frequently at the root of the nose, in front of the ear and at the anterior border of the masseter muscle. Diagnosis is suggested by their situation. The skin is freely movable over the cyst, which is usually fixed to the underlying bone, and the consistency is doughy. A dermoid cyst in the region of the root of the nose or anterior fontanel may be mistaken for a meningocele. The latter is distinguished usually by the fact that it is to some extent reducible and becomes more tense when the child cries or strains.

A small pedunculated tumor composed of fibrocartilage may occur in front of the ear or, less frequently, on the cheek in the line from the external auditory meatus to the angle of the mouth. These tumors are congenital, are not attached to the overlying skin, and the cartilaginous pedicle extends quite deeply into the subcutaneous tissue. They are benign but should be removed at some convenient time in infancy. An elliptical incision is made about the base and care is taken to remove all the cartilage.

**Hemangioma.**—The face is a common site for these tumors. The characteristics and treatment of the different forms have been referred to in another chapter.

**Lymphangioma.**—There may be a diffuse swelling or thickening of the soft parts of the face, especially the eyelids, the cheeks and lips. This swelling is composed of a series of cavities and channels filled with lymph —a cavernous lymphangioma. The involvement of the upper lip is most frequent. In the case of the lip partial excision may be practiced. In the diffuse swellings occurring elsewhere, radiotherapy has been advised by various authorities.

## MACROSTOMIA

Owing to the failure of the usual coalescence of the maxillary and mandibular processes the mouth may be unduly large. One or both sides may be involved and the condition is known as macrostomia. Treatment in the less extensive forms consists in freshening the edges of the cleft and suturing them. In the more extensive variety operation offers little. The normal aperture may on the other hand be diminished by excessive fusion of these parts resulting in microstomia. The mouth may be enlarged by a lateral incision through the cheek with suture of the skin and mucous membranes.

## CONGENITAL TONGUE-TIE

Congenital tongue-tie is a condition in which the tongue is bound down to the floor of the mouth by an abnormally short frenum. The deformity is actually rare though frequently parents ascribe to an imaginary tongue-tie

Fig. 106.—Macrostomia, Infant Three Weeks Old. (Case of Harold S. Vaughan.)

the fact that a child is slow in beginning to talk or has some defect in his speech. When the condition really exists and the tip of the tongue turns downward when an attempt is made to protrude it, the edge of the frenum should be cut. This is best done by slipping two fingers beneath the tongue, one on each side of the frenum, and snipping the edge with the scissors, after which the separation is completed by forcing the tongue backwards.

Care should be taken not to damage the vessels which run in the base of the frenum.

## ULCERS OF THE FRENUM

These are usually associated with a prolonged cough, often with whooping-cough, or may occur soon after the eruption of the lower central incisors. The ulcer results from abrasion of the frenum by the lower incisor teeth. In such cases a chronic inflammatory mass, a granuloma, may develop about the ulcer. This is distinguished from a mucous cyst by its firm consistence

Fig. 107.—Congenital Malformation of Nose.

and the superficial ulceration. The ulcer should be touched with 10 per cent silver nitrate or pure carbolic acid followed by alcohol. In the event of failure of this treatment the lower central incisors may be removed.

## MACROGLOSSIA

Macroglossia is the term applied to a variety of conditions in which the tongue becomes unduly large so that it tends to be protruded from the mouth. In its typical form it occurs as the result of lymphangioma, is often congenital and may affect the whole tongue, though usually it is limited to the anterior two-thirds. The enlargement may be progressive or it may remain stationary for a time and then begin to increase rapidly as a result of infection. The condition may be first evidenced at birth by the difficulty the child has in nursing. In the severe forms in which the tongue constantly protrudes from the mouth ulceration may take place.

When the condition is progressive or disabling, operation is indicated

FIG. 108.—GRANULOMA ABOUT ULCER OF FRENUM, INFANT ELEVEN MONTHS OLD.

and consists either in the excision of a wedge-shaped piece from the anterior part or of a wedge-shaped strip from the outer margin. A similar condition, but due to increase in interstitial connective tissue, occurs congenitally in mongolism and especially in cretinism. In the latter the condition often subsides under thyroid treatment.

## RANULA

Ranula is the term used to designate a cystic swelling in the sublingual region. The tumor is soft, fluctuant, bluish in color, ovoid or elongated

in shape and contains clear mucoid fluid differing from saliva. It may be congenital but it is usually noted in childhood or adult life. The swelling is not tender, increases in size slowly and causes symptoms only because of its bulk. When congenital it may push the tongue forward to such a degree as to interfere with nursing. While the tumor may push the tip of the tongue and the floor of the mouth upward and backward the great bulk usually lies buried deep in the tissues of the floor of the mouth.

There are many theories as to the origin of ranula and probably there is no single cause. They form first in the mouth and then burrow into adjacent regions. Some are in connection with the submaxillary gland, others apparently originate in the sublingual gland. Thompson's hypothesis is that the origin is from migrated portions of the cervical sinus. The character of the fluid differentiates ranula from cystic lymphangioma, which also may occur in the floor of the mouth. Whatever their origin, the important thing to remember is that the extent cannot be judged from the appearance in the mouth as the cyst may burrow into the submaxillary region of the neck and backwards to the base of the skull, where their inaccessibility is a serious problem.

*Diagnosis.*—The condition is recognized by the unilocular character of the cyst and its contents. To be differentiated are dermoid cysts, cystic lymphangiomata and thyroglossal cysts. There is a similar type of cyst which lies in or just beneath the mucosa of the floor of the mouth or of the under surface of the tongue. These cysts are small and originate in the mucous or submucous glands. Their excision is quite a simple procedure.

*Treatment.*—Complete excision is the ideal treatment but is often difficult or impossible. Where the entire sac cannot be removed the portion remaining behind is curetted, the wall swabbed with tincture of iodin and the cavity packed with gauze. In favorable cases the removal may be done through the mouth. In others the approach is by an incision in the submaxillary region of the neck. The important thing to remember is that the operation is often not simple and that an innocent-appearing swelling in the floor of the mouth may have very wide ramifications as mentioned above.

Very rarely a swelling is observed which develops rapidly beneath the tongue. This has been designated acute ranula. The tongue is pushed upward and to the opposite side, breathing may be difficult and there is great pain. This is probably caused by a sudden obstruction to the flow of saliva, possibly from impaction of a calculus in the duct. A similar, less marked condition may occur from partial obliteration of Wharton's duct as a result of swelling from trauma.

## ACUTE RETROPHARYNGEAL ABSCESS

Quite analogous to acute cervical lymphadenitis is the inflammation of the lymph-nodes in the retropharyngeal space. These lymph-nodes lie in the loose areolar tissue behind the pharyngeal wall and in front of the prevertebral group of muscles. In infancy and early childhood the nodes vary in number from three to ten and form a chain on either side of the median line, while in later years there are rarely found more than one or two nodes in the whole postpharyngeal space. The affection is essentially one of infancy and at least three-fourths of the cases occur in patients under one year. As in the neck, the process is probably never primary, but is secondary to a neighboring or remote infectious process occurring in the nose, sinuses, ears, mouth, teeth, pharynx or larynx, usually an acute rhinopharyngitis, which may be so mild as to escape notice. The pathology is the same as in the more frequent involvement of the external cervical nodes, and the process by no means invariably ends in suppuration. Retropharyngeal adenitis, not advancing to suppuration, and without clinical symptoms, is probably not at all an uncommon affection. Involvement of the cervical nodes is so often associated that in every instance of cervical abscess the possibility of a coexisting retropharyngeal abscess must be considered.

**Clinical Course.**—(1) Complete resolution may take place. (2) In the event of suppuration the abscess may burst spontaneously into the pharynx. (3) The pus may burrow laterally behind the great vessels and point at the posterior border of the sternomastoid. Less frequently, the prevertebral fascia may be so thinned out as to permit rupture and pointing at the anterior border of the sternomastoid. (4) The process may extend downward into the posterior mediastinum and exceptionally into the axilla.

**Clinical Features.**—The condition is most frequent at those seasons when catarrhal states are common. The course of the affection is very variable. Sometimes it is very acute, more frequently, however, the onset is insidious and symptoms may be so slight as not to attract attention until the local process has so advanced as to interfere to à greater extent with respiration or deglutition. The duration of the inflammatory process before the abscess forms is usually five or six days but may be two or three weeks. If the swelling is situated high up in the pharynx deglutition is difficult, while if lower down respiratory symptoms are marked. Often the first local sign is a difficulty in respiration, less frequently in swallowing, depending on the situation of the swelling. As the swelling increases the difficulty in respiration or in deglutition becomes more marked and the voice is nasal. There is a spluttering or gurgling respiration as though there were a collection of mucus in the throat. The posture with the head thrown

back to relieve the opening into the larynx is suggestive. Nursing may be impossible either from the difficulty in respiration or in swallowing. Sometimes there is regurgitation of food through the nose. There is usually a distinct bulging of the lateral wall of the pharynx. The uvula may be displaced and the tonsil pushed forward and often there is redness and edema of the adjacent mucous membrane. The swelling may often be made out better by palpation than by inspection, and this is particularly true when it is situated low down. While only induration may be made out, usually, by the time that the swelling is sufficiently large to cause marked symptoms, fluctuation is evident. It is uncommon, in patients who have exhibited symptoms, for the enlargement of the retropharyngeal glands to disappear without suppuration. Digital examination has been known to cause alarming symptoms and even death and should be made with care and only repeated when necessary.

**Diagnosis.**—In an illness of early childhood accompanied by difficulty in swallowing or respiration, whether the onset is acute or insidious, retropharyngeal lymphadenitis must be considered. Great dyspnea may lead to the diagnosis of laryngeal stenosis and tracheotomy has been done in such cases. Peritonsillar abscess is rare in infancy but does occasionally occur and may usually be distinguished by the medial displacement of the tonsil. Cervical Pott's disease occurs in older children, and may be differentiated by means of roentgenography. Rarely acute osteomyelitis of the vertebræ may cause confusion. Lymphosarcoma may cause a swelling difficult to differentiate.

**Prognosis.**—The general mortality in hospital cases is about 10 per cent. Death may occur from asphyxia from pressure, or as a result of rupture into the air passages. Fatal hemorrhage from erosion of a large vessel has been reported. Septicemia may result and aspiration pneumonia is another complication.

**Treatment.**—There has, at various times, been much difference of opinion as to the method of evacuating these abscesses. At one time an external incision posterior to the sternomastoid was the method of choice. At the present time, however, there is a quite universal agreement in opening the abscess through the mouth except in those abscesses resulting from caries of the spine or in those pointing externally in the neck. The abscess should be opened as soon as superficial fluctuation is detected. The patient is wrapped in a sheet to confine the arms, placed on a table on his back with the head over the end of the table and supported by an assistant. In older children a mouth gag, not opened too widely, is necessary. In smaller babies this is not necessary. The left index finger identifies the swelling and a small, moderately pointed artery forceps is introduced into the abscess and

the opening enlarged by separating the blades of the forceps. The child is immediately turned on its face. Anesthesia is definitely contra-indicated. In an occasional instance external incision into a definitely fluctuating area may be necessary.

## PERITONSILLAR ABSCESS

Peritonsillar abscess is less frequent in children than in adults and extremely uncommon in infants. It is generally secondary to acute tonsillitis and almost invariably unilateral.

The temperature is high, there is pain and difficulty in swallowing and the voice has a muffled sound. There is swelling, usually above and in front of the tonsil, less frequently behind it and the tonsil is displaced towards the midline. The surrounding parts, especially the uvula, may be much swollen.

**Treatment.**—As soon as the abscess has formed it should be opened. An incision, opposite the base of the uvula and in line with the anterior pillar of the fauces, is made in the most prominent part of the swelling. A knife, guarded with adhesive plaster to within one-third of an inch of the point, is used. A fine-pointed artery forceps may be used as in retropharyngeal abscess.

## VINCENT'S ANGINA

Vincent's angina is an inflammatory lesion in the mouth, pharynx or throat due to the combined action of a spirochete and a fusiform bacillus. It begins, usually, as an acute stomatitis, gingivitis or tonsillitis, subsequently leading to the formation of a pseudomembrane resembling that caused by the diphtheria bacillus. Later there may be distinct ulceration. The more common form is mild and slow in its progress with little general reaction. Less frequently the onset is rapid, the constitutional symptoms are more pronounced and there is greater tendency to ulceration. The diagnosis may usually be made by means of a smear. Cultivation of the organism in culture is difficult. The condition must be borne in mind by the surgeon as an occasional postoperative complication.

**Treatment.**—Prophylaxis consists in the ordinary methods of mouth hygiene. A dentifrice containing soap should be used.

In the presence of the disease careful mechanical cleanliness and the use of a dentifrice containing soap is essential to any form of treatment. In addition arsphenamin is applied locally. The ulcers may be painted with tincture of iodin or 5 per cent chromic acid. Measures to improve the general nutrition are important. In severe cases the intravenous administration of arsphenamin has been advised.

## THE JAWS

Fracture of the jaw is fortunately uncommon in children. When there is tendency to displacement, wiring of the teeth or an interdental splint is indicated.

Infection of the mandible may result from fractures communicating with the mouth but usually originates in relation to carious teeth. The inflammation about the tooth is followed by profuse periostitis which may lead to necrosis of a portion of the bone. There is less tendency to the formation of sequestra in children than in later life. The carious tooth is extracted. When evacuation of pus is necessary the incision is made within the mouth if possible.

**Epulis.**—The tumors that grow from the alveolar process of the jaw appear to spring from the gums, hence the term epulis. They really originate in the periosteum and are of the nature of giant-cell tumors. In the opinion of some observers they are of inflammatory origin. The tumor grows into the interval between two teeth or may arise near a carious tooth. It is bright red or violet in color, sessile, lobulated and may be superficially ulcerated. It may be readily stripped from the bone and after thorough removal shows little tendency to recur. Careful microscopic examination of the specimen removed is essential as a sarcoma may rarely occur in the same region even in children.

Rarely tuberculosis of the bone occurs. The diagnosis in such cases is often difficult and may be confused with that of a bone cyst.

The superior maxilla may be the seat of sarcoma, originating either in the periosteum or in the lining membrane of the antrum.

A sarcoma may also originate in the nasopharynx, occasionally the growth may be of the nature of a polypus and susceptible of removal but ordinarily surgery has little to offer in such tumors in children and radiotherapy should be tried.

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# CHAPTER XVI

## SURGÉRY OF THE NECK

### LATERAL (BRANCHIAL) CYSTS AND FISTULÆ

Early in fetal development, in the lateral walls of the anterior part of the foregut, five pharyngeal pouches appear. Corresponding to these pouches externally, indentations of the ectoderm occur, forming what are known as branchial grooves. Along the floors of these grooves ectoderm and entoderm come into contact and the two layers form thin membranes between the foregut and the exterior. Separated by the grooves are a series of rounded arches formed by a thickening of the mesoderm and known as the branchial arches. While six arches exist, only four are visible externally. This arrangement is most clearly observed in the fourth week of fetal life and in the course of subsequent development the grooves are completely obliterated. The first arch is known as the mandibular, the second as the hyoid. These two arches outgrow the others and form a considerable fold covering over the ones situated more posteriorly, and a deep depression lined with ectoderm, the cervical sinus is formed. As a result of inclusion or persistence of an isolated portion of this ectodermic lining, when the pharyngeal and cutaneous surfaces both close, the so-called branchial cyst develops. When the sides of a groove do not unite and there are openings in the skin and mucous membranes a complete branchial fistula occurs.

The position which the various grooves originally occupied may be pointed out in the fully developed individual and is of interest in the recognition of the different clinical conditions. A line drawn from the external auditory meatus to a point immediately above the hyoid bone indicates the original position of the first groove. The second may be defined by a line from a point on the anterior border of the sternomastoid just below the ear to the body of the hyoid bone. The position of the third and fourth grooves corresponds to a line drawn from the middle of the posterior border of the sternomastoid muscle to a point just above the suprasternal notch.

Branchial cysts are more common in males than in females, and while they may be noted in early life are seldom observed until adolescence or later. The origin is usually in the second groove but may be in the first or third. In most instances the cyst presents in front of the sternomastoid muscle opposite the great cornu of the hyoid bone to which

the wall of the cyst may be attached. Growth is slow but considerable size may be attained. The cyst is round, smooth, painless and often fluctuates.

Dermoid Cysts.—Another cyst with slightly different characteristics may be encountered in the lateral regions of the neck. This is apparently a true dermoid and contains sebaceous material. Such a cyst is usually found in the line of the first branchial groove, in the region of the mastoid or of the parotid. It lies beneath the aponeurosis and when in contact with the bone may erode it. It may be deeply situated in the neck, even projecting into the floor of the mouth.

**Treatment.**—Excision through an adequate incision is the only treatment. When the cyst is noted at an early age operation should be deferred until later.

### Branchial Fistulæ

A branchial fistula may exist at birth as a result of imperfect obliteration of a portion of one of the branchial grooves or it may result from the spontaneous or artificial opening of a branchial cyst. In the latter case the term branchial sinus is more appropriate. While commonly due to incomplete closure of the second branchial groove the external orifice may be situated at any point along the anterior edge of the sternomastoid, usually opposite the angle of the jaw, the upper border of the thyroid cartilage or just above the sternoclavicular joint. While the position of the external orifice varies, that of the internal, when it exists, is constant, being situated in the lateral wall of the pharynx close to the tonsil. The fistula may be complete or incomplete, the latter with either an external or internal orifice. When complete the course of the tract is constant along the medial border of the sternomastoid in front of the sternohyoid and sternothyroid muscles to the level of the great cornu of the hyoid bone, then passing behind the posterior belly of the digastric muscle between the external and internal carotid arteries and above the hypoglossal nerve to its internal orifice. The fistula is usually unilateral but may be bilateral and symmetrical.

**Clinical Features.**—The external orifice may be so minute as to scarcely admit the finest probe, or it may be so large as to permit the passage of food particles. An irregularly shaped bit of skin or skin and cartilage known as a cervical auricle may mark the opening. The opening leads into a tract which varies in length according to whether the fistula is complete or incomplete. The tract is lined with epithelium and from the orifice a clear, glairy fluid escapes which, in some cases, is increased in amount during the act of mastication. An incomplete internal fistula may often remain unrecognized. The course of the fistulous tract, if the opening is

situated externally, may be defined by a roentgenogram after the injection of some radiopaque fluid. The tract is often so tortuous as not to permit the passage of a probe. While the opening is usually so small as to appear of little moment the secretion may be irritating. Retention of this secretion or the passage of a probe causes a reflex disturbance manifested by a cough and pharyngeal irritation. The diagnosis may be confused with that of a sinus leading to a suppurating or tuberculous gland. The lack of inflammatory change and the character of the secretion will serve to distinguish the condition.

**Treatment.**—Palliative treatment is of little avail though occasionally the reaction set up by the injection of a few drops of iodin may result in the obliteration of an incomplete external fistula. Complete excision of the tract is the only certain cure. This is an operation of considerable magnitude and should only be undertaken by one thoroughly familiar with the anatomy of the neck. Operation should, if possible, be deferred until after the tenth year.

## MEDIAN (THYROGLOSSAL) CYSTS AND FISTULÆ

In early embryonal life there is a tract which passes from the isthmus of the thyroid gland to the foramen cæcum at the base of the tongue. This structure is lined with epithelium and is known as the thyroglossal tract or duct. It runs from the base of the tongue in the midline of the neck, usually passing through, though sometimes in front of or behind the body of the hyoid bone, thence along the anterior surface of the trachea to the isthmus of the thyroid gland. Under normal conditions this fetal structure begins to atrophy in the fifth week and closes by the eighth week, the foramen cæcum remaining to mark the old orifice on the dorsum of the tongue. When the duct is obliterated it becomes a cord of epithelium and traces of this remnant may be found in a number of individuals.

In certain cases the duct remains patent throughout a greater or less part of its extent. If a portion of the tract above the hyoid remains unobliterated a cyst will develop which is sometimes known as a lingual dermoid. Hemorrhage into such a cyst causes it to suddenly become enlarged or it may even rupture with discharge of its contents into the mouth. When a cyst develops in an unobliterated portion of the tract below the hyoid it is known as an infrahyoid cyst. The cyst wall is composed of dense fibrous tissue lined with columnar or squamous epithelium. The contents are usually thick and opaque, and are composed to a large extent of cellular detritus.

**Diagnosis.**—To be distinguished are sebaceous cysts, lipomata and tuberculous lymph-nodes, or even a suppurating lymph-node. A thyroglossal

cyst is not usually attached to the skin unless it has been the seat of an inflammatory process and it moves in the act of swallowing on account of its attachment to the anterior surface of the trachea.

**Treatment.**—Complete excision with any associated thyroglossal tract is the only treatment. This is usually best accomplished through a vertical

Fig. 109.—Thyroglossal Fistula (Complete).

incision in the midline. When the cyst projects into the mouth there is a tendency to some obstruction of respiration after operation due to edema and this possibility must be kept in mind.

### Median (Thyroglossal) Fistulæ

The tract may remain patent with an orifice on the skin or a sinus may result from incision or rupture of a previously existing cyst. Where the tract extends from the foramen cæcum to an opening in the neck the fistula

is complete. A patent tract may exist for years and attention be attracted to it only by some acute inflammatory process. As a rule the orifice is in the middle line at some point between the hyoid bone and the suprasternal notch; occasionally, when low down, the opening is slightly to one side. The tract is narrow and does not admit a probe to any depth. If the fistula is complete a solution of methylene-blue injected through the external opening may be seen to enter the mouth at the foramen cæcum. There is a mucous discharge. Particularly in the region of the hyoid this condition is difficult to distinguish from a sinus leading into a suppurating

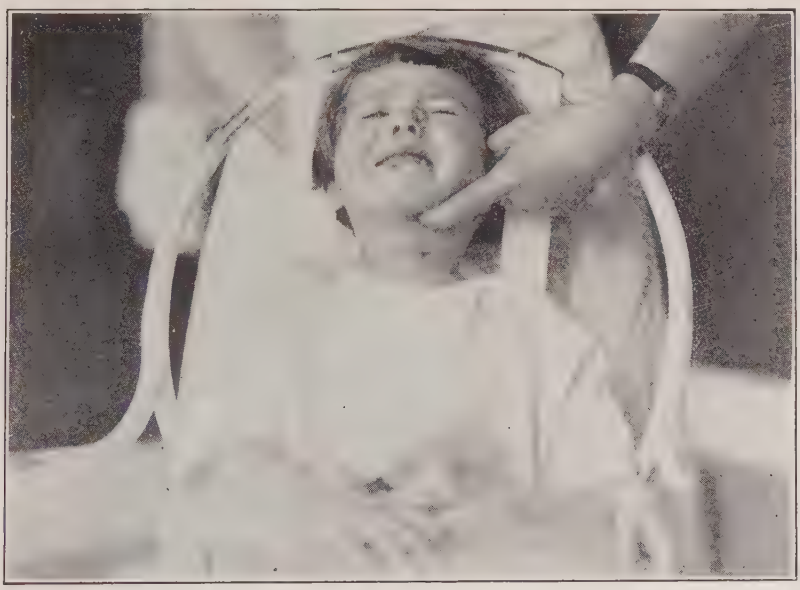

FIG. 110.—THYROGLOSSAL FISTULA.

gland. In the thyroglossal fistula the suppurating tract participates in the act of deglutition.

There is another type of fistula rarely observed and situated in the median line of the neck. It is placed superficially without any connection with the subjacent fascial planes and is attached above to the mandible and below to the manubrium by fibrous cords. This fistula is probably due to an abnormal infolding of the ectoderm.

**Treatment.**—Complete excision is the only cure. This is best carried out through a vertical incision in the midline. It is best not to attempt dissection of the tract alone but a cone of muscle surrounding the tract is cored out and the central portion of the hyoid bone is removed. If the condition is noted at an early age operation should be deferred.

## CERVICAL AURICLES

This term is applied to a small outgrowth composed of skin and cartilage, usually found along the border of the sternomastoid muscle. When it gives rise to disfigurement it should be removed.

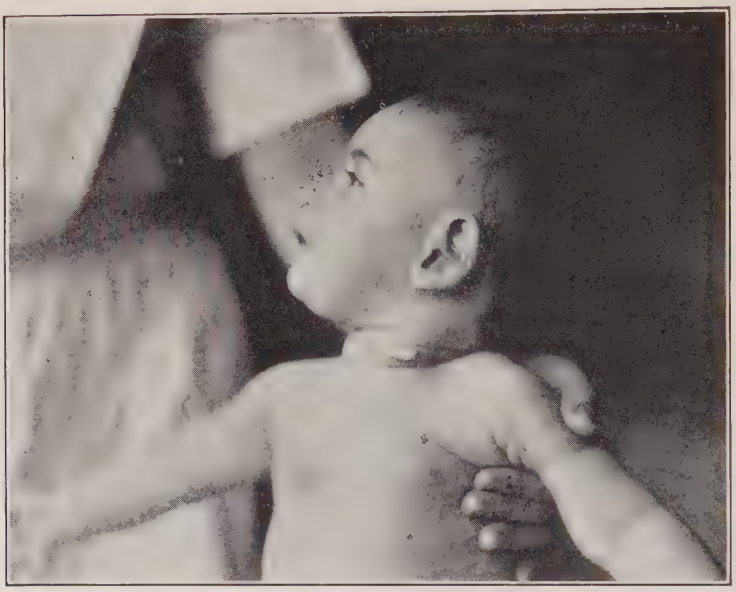

FIG. 111.—CERVICAL AURICLE.

## CERVICAL RIBS

Supernumerary ribs may be met with in connection with the seventh cervical vertebra. It is rare for the condition to cause symptoms in childhood and when discovered at this time is usually by accident.

## ACUTE SUPPURATIVE SIALO-ADENITIS

Suppurative inflammation of the salivary glands is unusual but may occur in the first or second week or at a later period. The parotid gland is the common site of the disease but the submaxillary or sublingual glands may be involved. The infecting organism is usually the streptococcus or staphylococcus. The infection may be hematogenous or direct by way of the excretory duct. Trauma, as by the obstetric forceps, predisposes to the condition.

Swelling, situated according to the gland involved, is the most important sign. The mouth of the corresponding excretory duct is reddened and pus may be expressed. The constitutional signs vary greatly

and the infant may be prostrated and refuse nourishment or nursing may not be affected.

The prognosis is poor in premature and weak infants.

**Treatment.**—The child should not nurse but the milk be pumped and fed from a bottle or spoon. Until there is definite fluctuation warm boric acid dressings are applied. When there is an area of softening an incision is made.

Fig. 112.—Suppurative Bilateral Parotitis, Infant Fifteen Months Old.

## ACUTE CERVICAL ADENITIS

This is an acute inflammation of the lymph-nodes which frequently terminates in suppuration. It is particularly common in infants and while the condition is probably always secondary to some focus in the skin or mucous membranes the primary lesion may be so slight as to escape attention and the adenitis may assume the appearance of a primary disease.

At all ages acute adenitis occurs in connection with the exanthemata. In such cases it may be severe and terminate in suppuration. In older children the adenitis which so frequently occurs in connection with simple catarrhal processes in the pharynx and rhinopharynx rarely ends in suppuration. In infants, however, acute adenitis is not only very common and often severe but frequently terminates in suppuration. The infecting organism is usually the streptococcus or staphylococcus.

There is active hyperplasia of the lymphoid elements associated with congestion and edema. Whether the process terminates in resolution or suppuration depends on the intensity of the infection and resistance of the individual. There may be considerable periadenitis, extending even to a

Fig. 113.—Acute Suppurative Cervical Adenitis, Child Nineteen Months Old.

widespread cellulitis. Both sides of the neck may be involved but usually suppuration occurs on one side only.

**Clinical Features.**—The nodes most frequently affected are those which drain the faucial tonsils and swelling appears below the angle of the jaw at the anterior border of the sternomastoid. There may be a gradual progression or the process may be very acute with extensive involvement of the adjacent tissues. While suppuration may be evident earlier it does not usually occur until the end of the second or third week. The constitutional reaction varies from a slight elevation of temperature to a temperature of 103°-105° with great prostration. While suppuration usually involves a single node it may extend from one gland to another. Where suppuration does not occur resolution is often slow but is usually complete after two months. In those occasional cases where disappearance of the swelling is delayed beyond this period the possibility of tuberculous involvement must be considered.

**Treatment.**—When there is an evident cause it must receive appropriate treatment. The best treatment for the local swelling is a moist dressing with a covering of oil silk or other impervious material. When resolution does not take place incision should be deferred until definite pointing takes place. There is nothing to be gained by early incision. After pointing is definite, an incision is made just large enough to admit a small rubber tube, and a moist dressing is applied. The dressing is changed daily and the tube removed on the second or third day. In most instances the abscess heals promptly. Occasionally one or more adjacent

Fig. 114.—Acute Suppurative Adenitis, Infant Ten Months Old.

glands suppurate, in which event a similar course is pursued. A considerable induration may persist for several weeks about the region of the gland. Local applications should be avoided in such cases.

## CELLULITIS OF THE NECK

As a result of infection from some lesion in the mouth there may occur a cellulitis affecting the subcutaneous tissue of the neck. This condition is of little moment. When, however, there is suppuration beneath the deep fascia there is a diffuse, brawny swelling affecting, usually, the submental or submaxillary regions and spreading into the lower part of the neck. While this infection may be primarily of the cellular tissue, it more usually results from periadenitis. The constitutional reaction may

be severe and not infrequently the edema and swelling is so great as to cause some embarrassment of respiration.

**Treatment.**—Treatment in such cases should not be delayed and an incision should be made into the brawny tissue at the point of greatest swelling. The incision should be deepened to extend through the deep cervical fascia beneath which the pus lies. After incision through the skin it is sometimes desirable to reach the deep-lying pus by means of a grooved director or moderately blunt artery forceps.

FIG. 115.—CELLULITIS OF THE NECK, CHILD TWO AND A HALF YEARS OLD.

## TUBERCULOSIS OF THE CERVICAL GLANDS

While in this country the incidence of tuberculosis of the cervical glands in children has greatly decreased in the past fifteen years, it occurs with sufficient frequency to make the treatment a matter of real importance to the practitioner.

In cervical glandular tuberculosis the bovine strain preponderates in large measure and the usual source of infection is an impure milk supply. In a certain proportion of cases, however, the human strain of organism is found and in such cases contact with a victim of pulmonary tuberculosis may often be traced. In those localities where the general incidence of the disease is low, probably due to adequate milk supervision, the relative proportion of cases due to infection with the human strain of organism is increased.

Although there is rarely evidence of its presence in the pharyngeal mucous membrane, this is nevertheless almost always the first situation reached by the tubercle bacillus whether inspired or ingested. Passage from the pharynx to the adjacent lymph glands is rapid and one of the earliest manifestations of infection is enlargement of that group of lymph glands nearest to the seat of inoculation.

**Mode of Infection.**—In the vast majority of cases the organisms gain entrance through the tonsils, adenoids or carious teeth, are carried thence in the lymphatic channels and are deposited in the nearest group of lymphatic glands. From a local area of absorption there is a local manifestation of disease. For a period of time, the exact length of which we cannot define, the disease remains local. This type of tuberculosis of the cervical glands is not associated, in the early stages, with a blood infection. When infection occurs in the first year progress is very rapid and the infection becomes generalized very early. With each succeeding year to adolescence there is a gradually increasing resistance to the disease.

More rarely, cervical glandular tuberculosis may develop as the result of a blood-borne infection. A tuberculous focus in any region of the body may be the source. Where there is the coincident appearance of diseased glands in multiple areas unconnected by lymphatic channels a blood infection is suggested.

Anything which lowers the general body resistance may predispose to the development of the condition. The first manifestation of involvement of the cervical nodes frequently follows one of the exanthemata.

**Anatomy.**—In order to appreciate the significance of enlargement of the glands in the neck familiarity with the situation of the various groups and the areas which they drain is essential. For the purposes of description the lymphatic glands of the neck may be divided into two groups: The pericervical group, a circular chain surrounding the base of the skull comprising (1) submental, (2) submaxillary, (3) parotid, (4) mastoid, (5) suboccipital glands; a series of vertical chains, three in number, comprising the anterior chain, of little surgical importance, and a lateral chain on each side of the neck, stretching underneath the sternomastoid and accompanying the vessels and nerves as far as the junction of the neck with the thorax. These lateral chains are the largest and most important of the various collections of cervical glands. Each lateral chain is divided into an upper and lower division by the line of the omohyoid muscle and these upper and lower aggregations are again divided into anterior and posterior groups by their relation to the great vessels of the neck.

These groups each drain different areas and it is worth remembering that lymphatics correspond closely with the veins and drain similar areas. A relatively small number of gland groups are especially liable to be affected

by disease. The special liability of these glands is due to the areas which they drain, the faucial tonsils, pharyngeal adenoids and teeth. Of the circular chain the submaxillary and parotid glands are the most frequently involved and of the vertical chain the two superior groups. In at least three-fourths of the cases the tonsillar gland, so called from the fact that it drains the area of the faucial tonsil, is the first affected. This gland is one of a group lying below the parotid gland and the mastoid process and covered by the sternomastoid muscle.

Fig. 116.—Early Case of Tuberculosis of Cervical Lymph-Nodes. (Dowd. Courtesy of *Ann. Surg.*)

A noteworthy characteristic of lymphoid tissue throughout the body in childhood is the frequency of hyperplasia, either without demonstrable cause or as the result of infection. Palpable cervical glands in apparently healthy infants and children occur frequently. That a gland becomes so enlarged as to be easily felt does not, in itself, give a definite basis for the clinical diagnosis of adenitis. Enlargement of the cervical lymph glands is of constant occurrence in children with infected or diseased tonsils, adenoids and teeth and the factor of mixed infection frequently masks the clinical picture of a true tuberculous lesion.

**Clinical Features.**—The age of greatest incidence is that between three and ten, the condition being comparatively rare in infancy and after the eighteenth year. The condition occurs in an acute and chronic form, the latter being much more common.

### Acute Tuberculous Adenitis

This form is characterized by a sudden swelling, usually unilateral, with moderate pain and tenderness. There is often little local evidence of inflammation and the constitutional reaction is usually slight. Within

a few days the local signs subside and the condition passes into the next class. Occasionally the local symptoms persist and caseation necrosis takes place within a few weeks.

### Chronic Tuberculous Adenitis

While this condition may occur in undernourished children the child affected frequently appears to be in excellent general health. At times the enlargement of the affected glands is so unobtrusive that it is difficult to determine the exact date of onset. The submaxillary group and the superior group of the deep cervical chain are affected most often, especially the so-called tonsillar gland. While at first a single gland may be involved the process quickly spreads to others and it is rare when only one gland may be palpated at the first examination. The swelling tends to increase slowly and steadily with often alternate remissions and exacerbations. In general the disease is unilateral but both sides of the neck may be affected. At times periadenitis, probably due to a superadded pyogenic infection, occurs and tends to obscure the outlines of the individual glands. Ordinary local and constitutional symptoms are mild or absent and it is only in exceptional instances that there is evidence of severe toxemia. There is, however, usually a failure to gain weight.

The course of tuberculous adenitis may run from a few months to several years. Complete resolution may occur or the process may be arrested by fibrosis and calcification. A large proportion of cases, however, will, if not interfered with, go on to caseation and softening. Mixed infection often plays a part. As the softening proceeds the overlying skin becomes red and indurated and eventually in this area rupture occurs. The lymphatic type, in which there is little tendency to caseation, is comparatively uncommon and may be mistaken for Hodgkin's disease. The least common type in children is the fibrous adenitis, in which the glands are small and hard with a great tendency to form adhesions to surrounding parts.

**Diagnosis.**—The diagnosis is by no means always easy and should not be made without due consideration. Any well marked enlargement of the anterior cervical glands that persists for several months after mouth and throat infections have been relieved should be considered tuberculous. Enlarged glands posterior to the sternomastoid are usually not tuberculous, especially in children. Both the acute and chronic forms must be differentiated from non-tuberculous adenitis. All infectious processes drain into the regional lymph glands and in the case of an enlarged gland search must be made at once for evidence of infection in the areas from which drainage occurs. Evidence of tonsillitis is the most common finding in

non-tuberculous adenitis. Nasopharyngitis, adenoids, carious teeth, any lesion of the mucous membrane or skin may also be causative factors. However, in most instances of tuberculous and in many instances of non-tuberculous adenitis the portal of entry is not marked by inflammatory changes and the adenitis appears as a primary disease. When the process is acute differentiation is aided by the fact that the non-tuberculous adenitis is most frequent in infancy, a focus is more frequently apparent, evidence of local inflammation and constitutional reaction is marked, swelling is rapid and progressive and suppuration or complete resolution occurs within two to eight weeks. At times diagnosis may be aided by roentgenography, as calcification occurs in a considerable proportion of cases of tuberculous adenitis.

Chronic adenitis may present great difficulties in differentiation. The swelling is often bilateral, may be related to obvious foci and rarely attains a large size. While the swelling may persist for months, unless the focus is removed, suppuration is rare. A positive tuberculin test is of relatively little value but a negative test is very suggestive. Hematoma of the sternomastoid muscle has only to be thought of to be differentiated. Syphilitic adenitis is usually widespread, there are frequently associated lesions and the Wassermann reaction is positive. Hodgkin's disease is rare but must be considered. It may ordinarily be differentiated by its widespread involvement, the absence of suppuration, the more marked constitutional reaction and the blood-picture. Lymphatic leukemia may be distinguished by the blood-picture, lymphosarcoma by its rapid development. Where there persists any doubt biopsy will settle the question.

**Treatment.**—Special prophylaxis includes the use of milk from tuberculin tested cows or of that which has been boiled or pasteurized and the care of the mouth, teeth and throat. Removal of tonsils and pharyngeal adenoids will obviate possible portals of entry for the tubercle bacillus. During an attack of known tuberculous adenitis it is probably better to dispose of the disease in the glands before removal of the tonsils and adenoids unless they are badly infected.

There is striking lack of unanimity of opinion as to the best method of treatment. The advocates of so-called conservative measures would restrict surgery to the aspiration of an abscess, while the radical surgeons would advise complete and wide excision as soon as the diagnosis is made. Until there is a specific treatment for the disease the middle course would seem wisest and a careful use of general measures combined with surgical operations where indicated would seem to be the method of choice.

The general treatment of tuberculous glands is the same as for tuberculosis elsewhere. Certain general measures should be associated with

any special form of treatment. These measures comprise the best living conditions possible under the circumstances, including fresh air in abundance with a liberal diet. In all cases a careful search for and eradication of any local source of infection is essential. Following this, if the glands are in an early stage they may subside and local treatment be unnecessary. In doubtful cases two or three months may be allowed to see the effect of general treatment. If at the end of this period the glands are larger, or if economic factors or lack of coöperation exist, removal is advised, while if they are smaller they are watched for a further period of two or three months. Where the diagnosis is definite and the disease is limited to the tonsillar and adjacent nodes, the indication is clear for the prompt and radical removal of the glands in this region. In such case the result is excellent and the disease is completely eradicated without material scarring. Where the disease is more widely disseminated and radical excision may be complicated by nerve or vessel injury, the indication is not so definite. In such cases conservative surgical operations combined with general treatment probably give the best results. Operation should be avoided during an attack of periadenitis.

A great variety of local measures have been advocated but very few have proved of value and any local skin applications are to be discouraged. Various modifications of Bier's hyperemia have been used, apparently with some success in the hands of certain reporters.

There are many enthusiastic advocates of radiotherapy and in certain well selected cases it is of undoubted value. Where the disease involves several groups of glands and is of the lymphoid character with little tendency to caseation, and in the case of sinuses, radiotherapy seems to be particularly valuable.

Heliotherapy, either artificial or natural, is very useful and should find a place whenever possible in treatment by any means.

Surgery combined with heliotherapy is probably the most satisfactory treatment in the great majority of cases.

## CYSTIC HYGROMA

The neck is the part of the body most richly supplied with lymphatics and is not infrequently the site of lymphatic cysts of considerable size. While these swellings probably exist at birth, it is during the first few months that they grow with rapidity and assume a large size. The actual extent of such a cyst varies within wide limits and there is a great tendency to burrow between other anatomical structures. The cyst is probably a form of rapidly growing lymphangioma, is multilocular, its walls are thin and the content is a thin, clear or blood-stained fluid. One explanation

of the existence of these hygromata is the peculiarity of embryonic sequestration of lymphatic tissue to be endowed with the power of persistent irregular growth.

Fig. 117.—Lymphangioma (Cystic Hygroma) of Neck Involving also Left Eyelid, Infant Six Weeks Old.

The anterior portion is cystic, the posterior portion cavernous.

**Clinical Features.**—The cysts are lobulated, the overlying skin is normal in appearance and not adherent. There is no pain. When the loculi are small the tumor is elastic in consistency, when the cavities are large there is fluctuation. In the latter case, however, the cyst is never tense

Fig. 118.—The Same Patient as in Figure 117 at the Age of One Year.

Note almost complete disappearance of lymphangioma evidenced by redundant skin. There has been no treatment.

Fig. 119.—Lymphangioma of Neck.

and the cavity does not seem to be filled to its capacity. Both types may occur in the same tumor, a portion being firm and elastic and the remainder fluctuant. Ordinarily there are no local symptoms other than those produced mechanically by the size of the tumor. Occasionally the cyst may be the seat of inflammation. There are undoubted instances of partial or complete spontaneous disappearance of these cysts.

**Treatment.**—There is no urgent indication for operation. In the large cysts operation is a procedure of considerable magnitude and one little suited to infancy. There is an appreciable chance of partial or complete spontaneous disappearance. Therefore operation should be deferred until the infant is at least eighteen months or two years old. Even at this age, unless there has been diminution in size to a considerable extent, operation should be again deferred. When operation is undertaken the surgeon must be prepared for an extensive dissection. If complete removal is possible the result is good. If the removal is only partial recurrence is to be expected and in such wounds there seems to be a definitely increased tendency to infection.

## THE THYROID

The relation of the thyroid health of the mother to the growth and function of the thyroid of the child has been referred to in Volume III of this series. Congenital goiter and tumors of the thyroid have been discussed in the same volume.

**Inflammatory Processes.**—Evidence of severe infection of the thyroid gland is unusual. When it does occur the infection is usually hematogenous and in the course of one of the acute infectious diseases. The infecting organism is often a streptococcus. The gland becomes enlarged and tender, there is difficulty in swallowing and in breathing and the process may go on to suppuration. The condition may be confused with acute cervical lymphadenitis. In the more serious form the disease may prove fatal by inducing obstructive edema of the underlying air passages.

In the event of recovery the destruction of the gland may be so complete as to result in thyroid deficiency in later life.

*Treatment.*—In the beginning warm, moist dressings may be tried. If the process progresses, an incision should be made over each lateral lobe deep enough to incise the capsule of the gland and relieve the tension.

Tuberculosis of the thyroid gland has been reported.

**Acquired Goiter.**—During the formative period there may be a physiologic enlargement of the thyroid which is self-corrected as at puberty. However, acquired goiter does occur in children and is not very uncommon in those regions where goiter is endemic. While there is scarcely

enough evidence at hand to call all simple goiters in children colloid, yet in this country that is apparently the usual type.

As a rule the simple goiter in children is symptomless and the child appears in excellent health. In a certain proportion of these cases sponta-

FIG. 120.—ADENOMA OF THYROID, GIRL FOUR AND A HALF YEARS OLD. (Case of Frank S. Mathews.)

neous cure may be expected but others will give rise to the adenomatous type of goiter with its potential danger later in life. It is said that adenomata seldom develop before twelve and that prophylactic treatment with small doses of iodin or desiccated thyroid is indicated between eight and ten. This phase of the subject has been discussed elsewhere. Even in children iodin must be administered with caution in the presence of adenomata

as the one exception to the rule that adenomata do not become toxic during childhood is the occasional instance of iodin hyperthyroidism.

When the gland has an unsymmetrical appearance the presence of adenomata may be suspected even though the nodules are not palpable.

FIG. 121.—HYPERTHYROIDISM IN CHILD NINE YEARS OF AGE.

Mother had hyperthyroidism, child had pus in urine and was treated for urine infection for eight months; this was followed by bulging of the eyes and enlargement of the neck, dyspnea on slight exertion, pulse 130. Very ill after thyroidectomy. (Dinsmore. Courtesy of *Surg., Gynec., & Obst.*)

FIG. 122. — HYPERTHYROIDISM IN CHILD TEN YEARS OF AGE.

Child always nervous and irritable, had slight difficulty in speech, thyroid enlarged with bruit and thrills, nervousness, tachycardia, emaciation, exophthalmos developed nine months after symptoms were noticed. Interval of three months between ligations and between second ligation and lobectomy; every operative procedure followed by marked reaction. (Dinsmore. Courtesy of *Surg., Gynec., & Obst.*)

Age exercises a predominant influence in the choice of procedure. Even in the presence of definite adenomatous goiter there is usually no urgent necessity for operation until early adult life. The integrity of the thyroid gland should, if possible, be preserved until full growth is attained. Pressure symptoms or iodin hyperthyroidism are the two indications for partial thyroidectomy in adenomatous goiter before the age of twenty-one.

The incidence of hyperthyroidism in children is probably greater than is generally supposed. Dinsmore recently reported forty-eight cases in children under fourteen years, thirty-seven of whom had been operated on. In a very small percentage of cases an induced hyperthyroidism results from the prophylactic use of iodin. In such cases the condition usually disappears promptly when the iodin is discontinued. In the other cases there is, in general, no factor to which the disease can be attributed. There is an abrupt onset and a rapid clinical course. Nervousness and irritability are usually first noticed by the parents. Enlargement of the thyroid with rapid pulse and exophthalmos follow. Loss of weight is not a constant symptom. According to Dinsmore, the treatment of hyperthyroidism is the same in children as in adults. These children, however, are extremely susceptible to every form of stimulus and must be handled with great care. They are poor operative risks and require the same careful handling as do severe cases in adults. The procedure in many instances has been a preliminary ligation of one superior thyroid artery, followed in a few days by that of the other. Partial thyroidectomy is done three months later. In the presence of foci of infection the goiter should be removed first. On the other hand, Fraser says that the prognosis is better in the child than in the adult and that the majority quickly subside under medical treatment.

## THE THYMUS

In infants hyperplasia of the thymus may be accompanied by characteristic and often dangerous symptoms. Such symptoms are breath-holding, stridor with cyanosis and asthma, any of which may be followed by weakness, unconsciousness and even death. In other instances of extreme thymic enlargement no symptoms are found. The only reliable test of enlargement of the thymus is obtained by use of the Roentgen ray. Where definite enlargement has been demonstrated, whether the condition is accompanied with symptoms or not, radiotherapy is probably indicated. This form of treatment is harmless and has apparently been shown to be efficacious in reducing the size of the thymus. Certainly it has superseded surgical removal of the gland. The chief interest to the surgeon in this condition, lies in its relation to sudden death from apparently trivial cause.

When an infant is brought for any type of operation and gives a history suggestive of thymic enlargement a roentgenogram of the chest should be made. If the thymus is shown to be enlarged radiotherapy is instituted if the operation is one of choice. In cases of emergency the condition is explained to a responsible member of the family, the anesthetist and nurses are warned and every possible care taken to guard against anesthetic accidents.

**Status thymicolymphaticus.**—The association of sudden death with enlargement of the thymus has long been noted. Such an enlargement, however, is but one of a series of anatomical conditions, including lymphoid hyperplasia, variously situated but particularly in the mucous membrane of the gastro-intestinal tract, and hypoplasia of the heart, the aorta and the blood-vessels at the base of the brain. The relative involvement of the different structures varies. In involvement of the thymus alone the condition is known as status thymicus. When the lymphatic system alone is affected the term applied is status lymphaticus. A combination of the two is called status thymicolymphaticus. A certain proportion, estimated by some as high as 10 per cent of all human beings, are the subjects of this condition and yet sudden death in such subjects is very rare. Such individuals are thought to be peculiarly susceptible to infection yet the majority are free from this susceptibility.

It is said that, to a certain extent, individuals the subjects of these anatomic changes, may be identified by external appearance. Symmers describes them as "fair haired or dark, blue eyed or brown, thin lipped, pink cheeked, alert to the point of precocity, with velvety skin, thin long bones, shapely limbs and graceful movements—born beautiful but a prey to infection and a bad risk." In Fraser's words: "They are pale, well nourished children, somewhat above the average height, the skin is thick and pasty looking, the hair deficient, the nervous system is impaired and they are slow and deliberate in their movements."

I have never yet been able to recognize the state in the living from external appearances, and the knowledge that I was dealing with a child the subject of status thymicolymphaticus, has always been derived from the pathologist in the report of an autopsy.

If a practitioner believes from the evidence at hand that a child is the subject of this condition, the parents should be warned and the child guarded as far as possible from all unusual stimuli. Anesthesia should be administered only in case of urgent necessity. If a roentgenogram reveals an enlarged thymus, radiotherapy should be instituted

It is a matter of interest that in autopsies on patients the subjects of status thymicolymphaticus, a meticulous search may reveal another adequate cause of death such as bronchopneumonia or sepsis. Symmers believes that sudden death in these cases may be brought about in at least two ways. One due to anaphylactic phenomena, the other to spontaneous rupture of a hypoplastic cerebral vessel. He has never been able to implicate the enlarged thymus as a mechanical factor in the production of death.

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# CHAPTER XVII

## CONGENITAL MALFORMATIONS AND TUMORS OF THE BACK

### SPINA BIFIDA

Before considering the various conditions in detail a brief description of the method of development of the spine and spinal cord is desirable. The central nervous system first appears in the dorsal midline of the embryo as a thickening of the surface ectoderm which is called the medullary plate. This plate, folding from without inwards on itself, forms the medullary groove which sinks deeper and deeper into the underlying mesoblast until by fusion of its edges the groove is converted into a tube, the neural canal. This canal remains and continues its growth independently of the integument and around it are developed all the nervous elements of the cord. In the meantime, even before the medullary edges have fused, an increase in the size of the cephalic portion becomes apparent and one can differentiate the brain from the spinal cord. Very early in development there is a communication between the medullary groove and the digestive canal. This communication is known as the neurenteric canal and its existence has an important bearing on the origin of certain congenital tumors in the region of the sacrum. From the mesoblast surrounding the medullary groove the spinal meninges and vertebræ are developed. There are three centers of ossification for each vertebra, one for the body and one for each half of the posterior arch. The complete arch results from the fusion in the midline posteriorly of the two lateral centers of ossification. This fusion begins in the mid-dorsal region and the lumbar and sacral regions are the last to have a bony roof. In the development of the embryo the growth of the neural tube is outstripped by that of the vertebral column. At the sixth month of fetal development the termination of the cord is at the lower end of the sacral canal. At birth the end of the cord is at the level of the third lumbar vertebra and at the end of the first year at the level of the first lumbar vertebra. From this relative decrease in the length of the cord arises the obliquity of the spinal nerves which are originally directed horizontally outward.

The term spina bifida denotes a congenital defect of the vertebræ and in most instances is associated with some protrusion of the contents of the spinal canal. The condition is a very distressing one and occurs about once in one thousand births. This estimate does not include spina bifida

occulta, which is often not recognized in infancy. The two sexes are equally affected. The defect usually involves the posterior arches but in rare instances the protrusion takes place through a lateral or anterior defect.

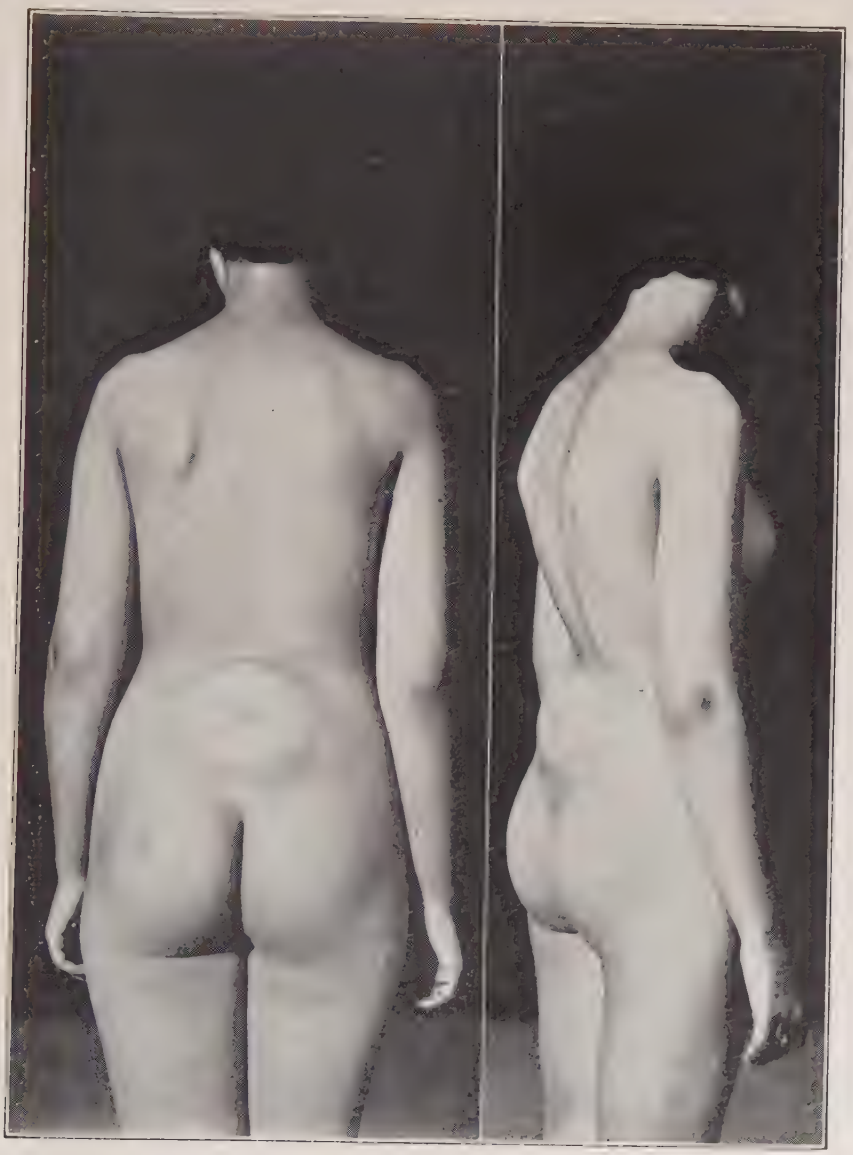

FIG. 123.—LIPOMA ASSOCIATED WITH SPINA BIFIDA OCCULTA IN A GIRL OF THIRTEEN YEARS. Talipes equinus and trophic ulcers of the heel were also present.

While the defect may be confined to a single vertebra, more often it involves more than one. The condition is due to a failure in development and its anatomy is readily understood if the method of development of the spine

FIG. 124.—SPINA BIFIDA OCCULTA IN A BOY THREE AND A HALF YEARS OLD ASSOCIATED WITH DIMPLING AND SCARRING OF THE SKIN AND OVERGROWTH OF HAIR.

There are no symptoms and no demonstrable nervous defects.

and spinal cord is considered. Any interference with the fusion of the edges of the medullary plate will of itself cause a corresponding interference with the development of the vertebræ forming the spinal canal in that region. The cord remains adherent to the ectoderm and the structures which should be formed between the cord and the skin are undeveloped. In certain cases the defect in the neural canal is so slight that in the fully developed embryo no trace of defect remains in the cord itself but its existence is revealed by an imperfection in the spinal meninges, with a corresponding defect in the vertebral canal. The fact that hydrocephalus is often associated with spina bifida or occurs as a postoperative complication suggests that increased cerebrospinal pressure may be a contributing factor in the etiology of the condition.

**Spina bifida occulta.**— When the skeletal defect is not associated with any protrusion the term spina bifida occulta is applied. The simplest forms of this type are those in which the spines of one or more vertebræ are bifid. There are no symptoms and the condition is not associated with nervous defects. In the normal spinal column the fourth sacral sometimes and the fifth sacral and coccygeal vertebræ always present this defect. Frequently it is encountered in the higher sacral and lower lumbar vertebræ without any associated lesion of the meninges or cord. More rarely the spinal cord is fully developed but there persists a band of fibrous tissue connecting the meninges of the cord with the overlying skin through the vertebral defect. In this type there may or may not be a dimpling or scarring of the skin adjacent

FIG. 125.—SPINAL MENINGOCELE IN AN INFANT FOUR MONTHS OLD.

FIG. 126.—MENINGOCELE IN CERVICAL REGION.

to the defect. Pigmentation, a nevus or, more frequently, an overgrowth of hair mark the area. Abnormal fat development or a dermoid cyst may be associated. A certain number of these cases probably represent small meningoceles which have been obliterated in early life.

**Meningocele.**—Meningocele consists in a protrusion of the spinal meninges through the vertebral defect which may be very small. The protrusion, usually pedunculated, is sometimes sessile and is covered with normal skin or parchmentlike membrane. The cavity contains cerebrospinal fluid but usually no nerves.

**Meningomyelocele.**—This is the variety most frequently met with. Associated with the protrusion of the spinal meninges is some portion of the spinal cord spread out over the dorsal aspect of the sac. The vertebral defect is usually extensive, the tumor is large and has a broad base. The coverings change from normal skin at the base to a thin translucent mem-

FIG. 127.—LARGE MENINGOMYELOCELE IN AN INFANT EIGHT MONTHS OLD.

brane as the summit of the tumor is approached. At the summit there is frequently an area of what appears to be granulation tissue. This area marks the site of the attached cord. When the tumor is low down the tip of the cord is attached and the spinal nerves cross the sac to reach the intervertebral foramina. Higher up in the spine the cord is attached by its dorsal aspect and passes on down through the protrusion to reach the spinal canal lower down. The cerebrospinal fluid is collected on the ventral surface of the cord.

**Syringomyelocele.**—This type resembles the meningocele with the difference that the cerebrospinal fluid is collected within the central canal and from distention of the canal the substance of the spinal cord is so greatly thinned out as to appear to form a portion of the lining of the sac. While the skin may be changed as in the preceding type there may be well-formed skin covering the tumor marked only by pigmentation or excessive

formation of hair. Differentiation from pure meningocele is important.

**Myelocele.**—This is the gravest of all such defects and is usually incompatible with postnatal life. In this type the arrest in development occurs very early and the central canal opens directly on the surface. There is a red and vascular area at the bottom of which the central canal may be made out and from which spinal fluid exudes.

**Anterior Spina bifida.**—This type is exceptional and is characterized by a defect in the bodies of one or more vertebræ with a protrusion of the contents of the spinal canal, usually into the pelvis, the sacral region being most frequently involved. The protrusion is usually large and does not contain nerve tissue.

*Clinical Features.*—The local symptoms are due to the presence of the cystic tumor and the changes in the integument associated with the different types. The tumor is filled with cerebrospinal fluid, is in communication with the subarachnoid space and varies in volume. The size is decreased when the head is lowered and the volume is increased by crying, etc. Fluctuation may often be made out between the fontanel and the tumor. If the tension of the contained fluid is low the edges of the spinal defect may be palpated. It is never desirable to attempt to replace the fluid in the spinal canal as the increase in pressure may result in unpleasant symptoms. Save in some cases of meningocele and spina bifida occulta where the local signs are the only evidence of the abnormality, there are associated phenomena depending upon involvement of nerve tissue. These phenomena are motor, sensory and trophic and vary from interference with the anal reflex to complete motor and sensory paralysis of the lower extremities with paralysis of the rectum and bladder. In but few cases, even of pure meningocele, is there perfect function of the sphincters. In every case the presence or absence of the anal reflex should be demonstrated by pricking the skin of the perineum with a pin. In most instances the evidences of nerve involvement are present at birth. The paralysis may be limited to certain groups of muscles or to one extremity. Various forms of talipes are common. The upper extremities usually escape involvement even when the defect is high. In spina bifida occulta, if, as sometimes happens, there is no change in the appearance of the overlying skin, the condition may not be suspected until the tenth or eleventh year or later when trophic disturbances, paralysis or interference with the function of the rectum and bladder may direct attention to the possibility of some spinal abnormality. These delayed symptoms are due to the fact that the band of fibrous tissue connecting the spinal meninges with the overlying skin does not grow proportionately with the surrounding tissues and there results more or less severe compression of the cord and nerve roots. In rare instances a pro-

trusion may develop. Various congenital malformaitons in other parts of the body may be associated. The frequent association of hydrocephalus either as a primary condition or as a postoperative complication has been pointed out.

*Clinical Course.*—The clinical course of the individual case depends not only upon the type of the condition but also upon the presence or absence of a complicating hydrocephalus. Spina bifida occulta is often

Fig. 128.—Meningomyelocele in an Infant One Day Old.

not discovered until adult life and the prognosis of life is usually excellent. The cystic variety is much more frequent and the prognosis is grave. Meningocele is the least common type of the cystic variety and has the most favorable outlook. This is due to the fact that the tumor may be covered with unchanged skin and there is relatively little involvement of nerve tissue. Meningomyelocele is the most frequent variety and while it is not incompatible with life the outlook is poor. Syringomyelocele is less frequent and has a somewhat better outlook. Myelocele is inevitably and rapidly fatal.

Anterior spina bifida is very rare and usually manifests itself as a cystic tumor in the pelvis. Diagnosis during life is exceptional. Not less than 80 per cent of all cases of the cystic variety die during the first year and another 10 per cent within the next few years. Even in the event of sur-

Fig. 129.—Same Patient as in Figure 128, Nine Months after Operation.

Fig. 130.—Large Meningomyelocele in Lumbar Region

Sac has ruptured. Note pouting of anus, absence of gluteal folds and deformity of feet.

vival the majority of those affected are more or less completely incapacitated as a result of the associated paralysis and deformities. The largest number die during the first month, death being most frequently due to rupture of the sac, meningitis or hydrocephalus. In exceptional instances a spontaneous cure occurs with gradual shrinkage of the sac.

*Differential Diagnosis.*—The occulta and the anterior varieties will not be confused. Of the three types of the cystic variety meningomyelocele is readily recognized by the three zones which characterize the surface of the tumor. Meningocele and syringomyelocele may be confused because each may be covered with unchanged skin. In the former, however, there is more likelihood of a narrow neck with a small vertebral defect, while in the latter the base is broad and the involvement of nervous tissue is usually greater. If the coverings are not too thick, transillumination may reveal the presence of nervous elements. In all types of spina bifida the extent of the bony defect is best shown with the aid of roentgenography. Certain small mixed tumors growing from the sacral region have clinical features which closely resemble those of a spina bifida.

*Treatment.*—The condition is a distressing one and treatment in the majority of cases is unsatisfactory. The limitations of operative treatment should be carefully considered. Practically the only thing which can be accomplished by operation is removal of the cystic tumor without increasing the paralysis. This will lessen the chance of meningitis. In certain cases the paralysis will inevitably be increased by the necessary steps of the operation. Exceptionally part of the paralysis is the result of tension on the nerves due to traction on their points of attachment to the sac wall and removal of the tumor will lessen the paralysis. Hydrocephalus will develop in a considerable number of cases after operation. In such cases the sac of the spina bifida has very probably acted as a safety valve. There are certain definite contra-indications to operation:

1. Hydrocephalus
2. Complete paralysis of both lower extremities with or without recognizable involvement of the sphincters
3. Associated irreparable deformities

The choice of time for operation varies with different surgeons and with the different types of the condition. In the smaller meningoceles, where the tumor is covered with normal skin, operation should be deferred until after the first year. In all other varieties and in meningoceles which are large or in which the skin is changed, operation should be undertaken, in suitable cases, as soon after birth as possible. In comparing the operative mortality at this time with that at a later period, it must be remembered that in the older group there has been a survival of the fittest and that natural causes have produced mortality which might be attributed to surgery in the younger group. The operative mortality has been variously estimated but if the deaths within a few months after operation are included it will approximate 50 per cent and may be higher. In every instance the outlook should be carefully explained to a responsible member of the family

with the understanding that practically the only things to be gained are the removal of the cystic tumor and a lessened chance of meningitis.

*Operation.*—The operation consists in isolation of the sac at its neck. A long incision is then made through the side of the sac and the nerve elements are freed as carefully as possible and replaced in the canal. The redundant sac wall is cut away and the neck of the sac sutured with catgut or fine silk. This closure is reënforced by the flaps of fascia if possible and the skin closed. Plastic operations with a view to reconstructing a bony roof of the spinal canal are not indicated. In the low spina bifida the incision should, if possible, be transverse; elsewhere it is vertical. Under no circumstances should the area of the sac to which the cord is attached be turned in toward the spinal canal. It is impossible to disinfect this area and meningitis will almost invariably result. The cord segments distal to this point of attachment to the sac roof are so poorly developed that they are practically functionless and there is nothing to be gained by their preservation. The rational procedure is to cut free the cord as close to the sac wall as possible, the line of section being parallel with the sac roof. Every effort should be made to preserve intact the nerves arising from the cord above its attachment to the sac. Operation in the occulta variety is usually postponed until symptoms of pressure manifest themselves. Then the bony defect is exposed and the constricting band of fibrous tissue dissected free. Such an operation is not to be undertaken lightly and then only by one thoroughly familiar with the anatomical relations.

Palliative treatment consists in scrupulous cleanliness and protection of the cyst by means of a ring of cotton. When cerebrospinal tension is great, temporary relief may be obtained by withdrawal of fluid. Care should be taken to introduce the needle through healthy skin. The prospect of immediate recovery is greatest in those cases where the skin is intact. Hydrocephalus frequently follows operation and as the cause is unknown prophylactic measures cannot be adopted.

Various congenital errors in the development of one or more vertebræ associated with malformation of the soft parts result in greater or less degrees of deformity. Such developmental errors are most frequently met with in the cervical region. In the severe types there is reduction in the length of the neck so that the head is sunk between the shoulders.

## TUMORS OF THE SACROCOCCYGEAL REGION

There is a certain group of tumors which are congenital and are located in the region of the spine, most frequently in the sacrococcygeal region. They may occur as simple tumors, but more frequently are composed of more than one tissue.

**Teratomata.**—These tumors are present at birth and are often of considerable size. The tumor is usually covered with normal skin, its consistency varies and there may be fluctuation in parts. The large tumors may be pedunculated, being attached to the coccyx by a narrow neck. The actual structure is composed of a variety of tissues. There is usually no evidence of malignancy though there may be great variation in the rate of growth, some remaining quiescent for years while others increase rapidly in size. A small teratoma in the sacral region may closely resemble in appearance a meningomyelocele.

*Treatment.*—If local removal is possible the results of treatment are excellent. Careful hemostasis is essential. The incision should be as far from the anus as possible and every effort made to avoid wound infection.

Fig. 131.—Sacrococcygeal Tumor.

**Parasites.**—The region of the sacrum is occasionally the site of an embryonal parasite. Such tumors may contain developed formations but they may also be composed of a confused mass of tissues indistinguishable from the sacrococcygeal tumors described above.

**Dermoid Cysts.**—These may occur here as elsewhere.

**Coccygeal and Presacral Tumors.**—When the proctodeum invaginates to form part of the cloacal chamber it meets the gut anterior to the spot where the neurenteric canal opens into it. Therefore, there is, for a time, a segment of intestine behind the anus known as the postanal gut. This section of embryonic intestine disappears leaving only a trace of its existence in the coccygeal gland at the tip of the coccyx. From this body may develop a tumor composed of vesicles lined with columnar epithelium and filled with mucouslike fluid. These tumors spring from the anterior

surface of the sacrum or coccyx. They may be quite small or attain a size larger than a child's head. The surface is lobulated and fluctuation may be obtained in certain portions of the mass. They should be distinguished from anterior spina bifida by means of a roentgenogram.

*Treatment.*—When possible excision of the tumor is advisable. Access is gained by an incision lateral to the coccyx and sacrum. The tumor usually projects toward the rectum which necessitates careful dissection in this direction.

## CONGENITAL SACROCOCCYGEAL SINUSES AND FISTULÆ

In a considerable number of cases there is a funnel-shaped depression in the midline at the tip of the sacrum or over the coccyx known as the postanal dimple. This may be due to traction exerted upon the skin at this point by the remains of the neurenteric canal or by the caudal ligament. A slight degree of this malformation is very frequent and merely forms an anatomical curiosity. Occasionally, however, when the condition is more marked it becomes the starting point for complications which necessitate surgical intervention. The skin may be retracted to such an extent that one or more sinuses are formed, lined with skin furnished with hairs, sweat and sebaceous glands. These are often called pilonidal sinuses. This may be the starting point for irritation with resulting suppuration in the interior of the cavity. A regular cyst may form from retention of sebaceous and epidermal products in the little cavity. From the accumulation of secretions and subsequent infection there may be an offensive discharge and the condition may be mistaken for an anorectal fistula. They may also imitate closely fistulæ of bony origin. The invagination of sound skin at the periphery and the situation in the midline are points suggesting a correct diagnosis.

**Treatment.**—The best method of treatment is complete excision treating the wound as an open one.

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# CHAPTER XVIII

## SURGERY OF THE CHEST

Congenital malformation of the chest, such as deficiency of the pectoral muscles, absence of the sternum or cleft sternum, and the various anomalies of the ribs are rarely of surgical importance.

Acquired deformities usually result from rickets, occasionally from scurvy, and have been referred to elsewhere.

## INJURIES

Fracture of the ribs is uncommon in childhood, except in association with disease or as a result of severe crushing injuries.

The elasticity of the walls of the thorax is especially marked and extreme compression may be sustained without bony injury. It is important for the practitioner to realize that the structures within the thorax may be extensively damaged with little or no external evidence of injury. Such injuries are often followed by severe shock. When the symptoms of shock are delayed for one or more hours hemorrhage is suggested. In addition to the symptoms of shock the diagnosis of intrathoracic hemorrhage is based on the physical signs of pleural effusion, a roentgenogram and, finally, the aspiration of blood. While pneumothorax usually results from the laceration of the lung by a fragment of a broken rib, it may occur in the absence of such fracture. Rupture of the diaphragm may occur with evisceration of abdominal organs into the pleural cavity, occasionally with such slight symptoms that the injury is not detected until years later and then only by accident.

**Treatment.**—In all cases in which the thoracic viscera have been injured the patient must be kept absolutely quiet. Appropriate measures are taken to combat shock. If the ribs are fractured the chest may be strapped. In some instances this measure seems to aggravate the symptoms.

When there is hemothorax, treatment depends upon the extent of the hemorrhage. If the amount is moderate, aspiration should be deferred. If, however, at the end of ten days there is no diminution in amount the fluid may be withdrawn. Where the hemorrhage is so great as to result in marked dyspnea, aspiration should be carried out at once, but only enough fluid removed to relieve the dyspnea. If infection occurs the condition is treated as an empyema.

Fig. 132.—Traumatic Pneumothorax, Right without Fracture of Ribs.
The air was spontaneously absorbed and the lung fully expanded within ten days.

Pneumothorax seldom calls for special treatment. When, however, there is severe dyspnœa, relief may follow the escape of air through a hollow needle introduced into the pleural cavity.

**Subcutaneous Emphysema.**—Subcutaneous emphysema may be met with after injuries of the chest and may be progressive and widespread. In such cases incisions into the subcutaneous tissues are usually avoided on account of the danger of infection. In extreme cases, however, incisions are sometimes indicated and may prove of spectacular benefit. Subcutaneous

FIG. 133.—TRAUMATIC SUBCUTANEOUS EMPHYSEMA.

Boy of five years was struck by an auto. On admission to hospital there was extensive subcutaneous emphysema which by the second day had extended to the soles of the feet. Roentgenogram showed collapse of left lung and subcutaneous emphysema, no fracture of ribs. On the third day two incisions were made on each side of the chest. Air escaped freely from these incisions and the child was greatly improved on the following day. The emphysema had almost entirely disappeared in ten days and two weeks later the child was discharged in good condition. (Case of John Douglas.)

emphysema also occurs occasionally as a complication of bronchopneumonia, whooping-cough and other conditions. The diagnosis is easy and is established by the crepitation present in the tissues. The prognosis is determined by that of the underlying condition and if that is relieved the air may be expected to be absorbed within two weeks. Treatment is directed toward allaying cough and quieting the respirations.

FIG. 134.—ROENTGENOGRAM OF SAME PATIENT AS IN FIGURE 133, SHOWING COLLAPSE OF LEFT LUNG AND SUBCUTANEOUS EMPHYSEMA.

## MASTITIS

The mammary gland of the infant, which is very small, begins to enlarge just after birth and at the end of three or four days usually reaches the size of a pea. At this time a thin fluid may be expressed from the nipple. Five or six days may elapse before this secretion is apparent, although in exceptional instances it may appear as early as the first or second day. The

swelling and secretion increase until the middle of the second week. There is great variation in the intensity of this process and sometimes the tumefaction is the size of half a walnut. After two to three weeks the process diminishes and the swelling has usually entirely disappeared by the end of the fourth week. The process is symmetrical, the swelling is firm and the overlying skin appears normal. No treatment is necessary and ex-

Fig. 135.—Same Patient as in Figures 133 and 134 Four Months after Leaving Hospital.

pression of the secretion is to be avoided. If the swelling is marked a moist dressing and light bandage probably afford comfort.

Mastitis which may be added to this process is indicated by considerable swelling of the gland and edema, redness of the overlying skin and tenderness. The infection is derived either from the skin or from the blood stream. The condition is usually unilateral. The glands in the corresponding axilla may be enlarged.

Fig. 136.—Suppurative Mastitis in an Infant Four Weeks Old.

Fig. 137.—Swelling of the Mammary Glands in an Infant Eleven Days Old.

**Treatment.**—In the early stages a wet dressing retained by a light bandage is desirable and often no further treatment is needed as resolution takes place. When, however, fluctuation is apparent a small incision is necessary. Some authors attribute retraction of the nipple observed in later life to this procedure.

Fig. 138.—Lymphangioma (Cystic Hygroma) in the Region of the Right Breast.

In both sexes, at the time of puberty, certain changes are noted in the breasts. In the case of girls the gland increases in size and the nipple becomes sensitive and at times contact with undergarments is painful. The breasts rapidly develop and this sensitiveness disappears. The condition is rarely regarded of sufficient importance to demand medical advice.

It is somewhat different with boys. Most frequently any change is limited to engorgement and tenderness of the breasts which may last for twelve to eighteen months. Occasionally a true hypertrophy follows and

there is a progressive increase in the size of the breast. In such cases, which are exceptional, mastectomy is indicated.

## TUMORS OF THE BREAST

When a child of twelve to fifteen presents a swelling of the breast it is usually the so-called mastitis of puberty. It is well, however, to remember that tumors do occur at this time of life. Adenofibroma, mixed tumor and sarcoma are the types of growth which may be encountered.

**Diagnosis.**—In mastitis the entire gland is involved, there is tenderness and the condition is bilateral. In tumors there is an irregular involvement of the breast tissue and there is no tenderness.

Treatment is operative and the extent of the operation depends upon the nature of the growth.

## TUBERCULOSIS OF THE RIBS AND STERNUM

Tuberculosis of the ribs and sternum, although usually noted in adults, may occur in children. The rib is usually affected near its junction with the costal cartilage. The condition may be primary or secondary and in all forms an abscess ultimately develops. The pus almost always collects on the outer aspect of the bone and usually travels a considerable distance in working its way toward the skin, with the result that long and tortuous sinuses are formed which open at a considerable distance from the diseased bone. The onset of the disease is insidious and its progress slow, without pain or discomfort. Attention is usually first directed to the condition by a swelling with the characteristics of a cold abscess.

Treatment consists in radical excision of the affected bone and soft parts and closure of the wound without drainage.

Acute pyogenic osteomyelitis of the ribs and sternum is very rare in children.

## EMPYEMA

Empyema is a collection of pus in the pleural cavity, displacing and compressing the lung. It may be unilateral or bilateral and according to the extent and distribution of the exudate the empyema is spoken of as diffuse or encysted. In the encysted form the fluid may be confined by adhesions to the region of the diaphragm, to an interlobar fissure or to any large or small area of the pleural cavity.

The condition is one of the commoner surgical diseases of infancy and childhood and is most frequent before the age of five years. The great majority of cases occur as a complication of pneumonia, the infection of

FIG. 139.—LEFT EMPYEMA IN AN INFANT [illegible]

being by direct extension. While in older children and adults the lobar type of pneumonia commonly precedes empyema, in infants and young children the bronchopneumonic type is usually found. The pneumococcus is the organism most frequently encountered and is present in at least two-thirds of the cases. Less commonly the streptococcus or

FIG. 140.—ACUTE TUBERCULOUS PNEUMONIA LEFT LUNG.

The physical signs and roentgenogram suggest pleural effusion. Paracentesis of the chest was negative. Sputum aspirated through bronchoscope showed tubercle bacilli. Infant ten months old. (Bronchoscopy by John D. Kernan.)

staphylococcus is responsible. The staphylococcus infections are usually found in very young infants. Empyema may complicate any of the acute infectious diseases, notably scarlet fever and measles. In such cases the infecting organism is almost invariably a streptococcus. It is met with in pyemia from any cause and may occur in the newly born as one of the results of umbilical sepsis. The pleura may become infected secondarily to a suppurative process within the abdomen, in which case the colon bacillus is the usual organism. Very rarely there is direct extension from disease of the chest wall.

The fluid in the pleural cavity varies from a thin, turbid seropurulent exudate to a thick creamy pus in which are masses of fibrin and in amount from a few drams to one or more pints. The pleura is thickened and covered with fibrin. In time this fibrinous exudate becomes organized and adhesions between the visceral and parietal pleura result. The lung is more or less collapsed and in long standing cases may undergo sclerotic changes. Elmer Johnson has recently called attention to the frequency of pyopneumothorax resulting from the rupture of a subpleural abscess as a complication of bronchopneumonia in infants. The thin exudate is characteristic of infection by the streptococcus and is usually widespread and in large amount. In such cases the pleura may be only slightly altered with few or no adhesions. When the accumulation is large the heart is displaced and there may be bulging of the chest on the affected side. In neglected cases the pus may perforate the chest wall, usually anteriorly in the upper portion, or it may burrow into a bronchus and be expectorated.

**Symptomatology.**—When, as is usually the case, the empyema occurs as a sequela of pneumonia, the onset may be insidious and the symptoms of empyema follow those of the original disease without intermission. Indeed, there is often nothing in the symptomatology to call attention to it. The temperature, pulse and respiration are somewhat higher and the child appears sicker but there are no particular symptoms to direct attention to the developing empyema and the condition is suspected only because of some change in physical signs. In other cases, after the temperature has been normal, or nearly so, for several days, usually two to ten, there is either a sudden or gradual rise in temperature and the constitutional symptoms return. The temperature is not usually characteristic, and while it may be high and irregular, it may be only moderately elevated. In those cases which have existed for a long time there may be no fever at all. In other cases the onset may be so acute and the development so rapid that the empyema appears to be the primary condition. Practically invariably, however, there is an underlying lung infection. The streptococcus is frequently the infecting organism in such cases. When the empyema develops in the course of a pneumonia, the leukocyte count may rise somewhat but

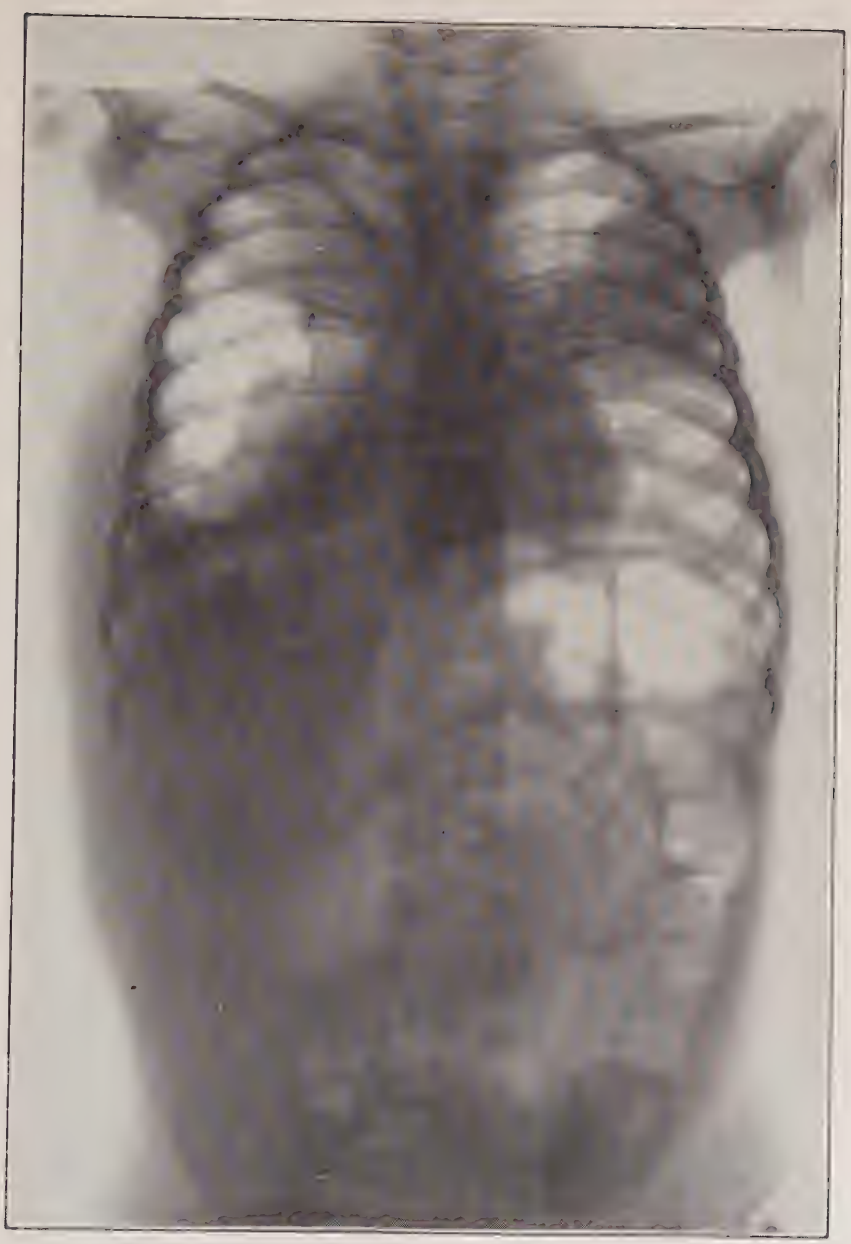

Fig. 141.—Pyopneumothorax, Right, Consolidation Left Lung, Child Ten Months Old.

is usually of little diagnostic value. In those instances, however, when the condition develops after an interval, the rising white count is suggestive. When there has been pus in the chest for some time, the symptoms are quite uniform and there is pallor, anorexia and loss of weight. A secondary anemia which may be extreme in some instances is practically the rule.

There is cough, dyspnea and an increased respiratory rate. When the condition persists for some weeks unrecognized or untreated the symptoms may resemble those of tuberculosis.

**Physical Signs.**—The most important physical signs of fluid in the chest are flatness, an increased sense of resistance to the percussing finger and displacement of the heart. This displacement is toward the healthy side in acute cases with much fluid and away from it in chronic cases with pulmonary collapse. When the amount of pus is small the cardiac displacement is slight or absent altogether. In young children where the empyema is often sacculated, this is frequently the case. Contrary to what might be expected, bronchial breathing and moist sounds may often be heard over the area of flatness. Fremitus may persist also in this region. It is these unexpected signs which may account for the fact that empyema is frequently overlooked. Where there is air as well as fluid the breath sounds may be diminished or absent and tympany, the coin sound, and succussion elicited. The stethoscope cannot be relied on alone as a means of examination. When the amount of fluid is great, bulging of the chest may be apparent. In every suspected case a roentgenographic examination is indicated and often proves of great value though it is sometimes confusing. In each instance it is essential that the diagnosis be confirmed by the insertion of an exploring needle and the presence and nature of the fluid definitely established.

**Diagnosis.**—While the recognition of an empyema which has existed for some time is often easy, in general the diagnosis is more difficult in the child than in the adult and the younger the child the more difficult it is. The bronchopneumonic type of infection predominates, the crisis is less clearly defined, the physical signs may be difficult of interpretation and the roentgenographic findings are often confusing. The most difficult thing to determine when the temperature does not come down or rises again after a free interval, is whether the abnormal physical signs are again due to consolidation of the lung or to a collection of fluid. In such cases the most important physical signs in favor of a collection of fluid are displacement of the heart and flatness with a sense of resistance to percussion. It is by the exploring needle alone that the diagnosis of empyema is positively established. The diagnosis of the interlobar type of empyema is particularly difficult and in this class of case a roentgenogram is often of great value. A large pericardial effusion may give signs indistinguishable from those of left-sided empyema. A large pulmonary abscess may be impossible to differentiate by physical examination. In both these instances roentgenography will often clear up the situation.

**Prognosis.**—Several considerations enter into the question of mortality. Age is perhaps the largest single factor concerned in determining

the prognosis. In infants under one year the mortality is very high, from 40 to 60 per cent. In the second year the death rate is definitely less, and after two years falls rapidly until in the period from four to ten the mortality from empyema is probably less than in any other period of life. The high mortality in the first two years is not to be attributed to failure to achieve satisfactory drainage or to other mechanical difficulties, but rather to the peculiarities of the acute primary pneumonia of infancy with its greater tendency to generalized infection of parts remote from the lung. When empyema alone is present recovery usually takes place. The infants die, not of the empyema, but of the generalized pneumonic infection which precedes the formation of the empyema and persists after its development. When an empyema presents itself merely as a residual abscess in the pleural cavity after the termination of the acute pneumonic process, the outlook is favorable. It is also usually favorable when the rise in temperature due to the empyema is separate from and follows after an interval the rise due to the original pneumonic infection. Pneumococcal infections present the most favorable outlook. The staphylococcus is somewhat more dangerous as an infecting agent and the streptococcus, particularly the *Streptococcus hæmolyticus,* the most dangerous of all. In empyema occurring in the course of a general infection, as a complication of the acute infectious diseases or of a suppurative process within the abdomen, the prognosis is unfavorable.

**Treatment.**—There is no single method of treatment applicable to all patients with empyema and individual consideration must be given to each patient. The methods at our disposal comprise: (1) Aspiration, (2) closed intercostal drainage, (3) open intercostal drainage, (4) resection of a portion of a rib with drainage.

*Aspiration.*—Before any operative procedure is undertaken the diagnosis must be confirmed and the nature of the fluid determined by the insertion of a needle. The needle should be inserted in that region where the signs are most definite, most often in the seventh or eighth interspace, in the posterior axillary line or just within the angle of the scapula. The syringe should be attached to the needle when it is inserted and every effort made to avoid the entrance of air into the pleural cavity. A needle with a short bevel and a caliber such as to permit the withdrawal of thick fluid should be used. Whenever the chest is explored one should be prepared to evacuate the fluid, if found, and this should always be done unless some form of operative procedure is to be carried out forthwith. It is not sufficient to have a history of withdrawal of pus from the chest; the operator must, in every instance, personally explore the chest before proceeding with the operation. In certain cases exploration reveals a few cubic centimeters of turbid fluid, culture of which shows organisms, and without further

procedure the patient goes on to uninterrupted recovery. In other exceptional cases, repeated aspiration of large amounts of pus eventually results in cure. However, in general, aspiration is of service chiefly as a palliative measure, until a more effective procedure may be carried out with reasonable safety.

*Closed Intercostal Drainage.*—Many methods have been devised to effect this type of drainage. I shall describe the one which has been in use at the Babies' Hospital for many years and which is known as "siphon drainage." Following exploration by means of a needle at the intended site of operation, a small incision, ½ to ¾ inch in length, is made through the skin and intercostal muscles. A firm, but not very stiff drainage tube, in size corresponding to a 24-28 F catheter, and about 12 inches long, is selected. The beveled end is grasped by a moderately pointed, curved artery forceps and introduced through the intercostal incision for 1 inch into the pleural cavity. The distal end of the tube is clamped during introduction and until complete connections are made. The thoracic tube is joined by a piece of glass tubing to a longer rubber tube of the same caliber which is connected to a bottle of about 1 pint capacity, one-third full of sterile salt solution. This bottle is plugged with a rubber stopper carrying two glass tubes, the longer of which is attached to the end of the tube and extends beneath the surface of the salt solution. The shorter tube serves as a vent for air as the contents of the bottle increases. The procedure is simplified if the entire apparatus is assembled and sterilized together. It is usually of advantage to fill the tube with water before its insertion to aid in establishing the siphon. Continuous drainage takes place from the chest into the bottle without the admission of air to the pleural cavity but the drainage may be interrupted at any time by clamping the tube. At first the saline solution should be changed two or three times daily after clamping the tube. Blocking by a plug of fibrin may often be corrected by "milking" the tube. If this is not effectual, suction by means of a syringe may be tried, or a small amount of salt solution allowed to run in. If none of these methods is successful the tube may be removed and replaced. Undoubtedly there is some merit in draining pus from the chest without admitting air to the pleural cavity. Any method of closed drainage, however, has definite limitations.

*Open Intercostal Drainage.*—An incision 1 to 2 inches long is made in the appropriate interspace and two rubber tubes joined together with a safety pin are introduced into the pleural cavity.

*Resection of a Rib with Drainage.*—An incision 2 to 3 inches long is made over the chosen rib and deepened to and through the periosteum. This membrane is stripped from the rib and a 1½ inch segment of rib is removed. The pleural cavity is opened through the bed of the rib and

two tubes introduced. Whenever a tube is introduced into the pleural cavity effectual means must be taken to ensure its being retained in place and particularly to prevent its falling into the pleural cavity.

The first three procedures should be carried out with local or no anesthesia. The last is best done under general anesthesia, open ether or nitrous oxid or ethylene oxygen sequence. Gas anesthesia is preferable when an expert anesthetist is available.

Certain data are essential before intelligent choice of a method of treatment can be made: (1) The age and general condition of the child. (2) The type of infecting organism. (3) The presence or absence of pneumonia. (4) The type of empyema, whether encysted or diffuse.

Given a child three years old or over, in good condition, with a pneumococcus empyema, with no active pneumonia or other major complication, I consider the indication plain for the primary resection of a portion of an appropriate rib. With this procedure and a careful avoidance of unnecessary exploration and trauma in the pleural cavity, a good result may be anticipated in the great majority of cases. However, in infants under eighteen months, in any case, and in older children with an active pneumonia or other major complicating factor, when the condition is bad from any cause, in long-standing massive empyemas, and in all streptococcus infections, the choice of a method of treatment, and the time of its application, become important. The chief indication for aspiration is the immediate relief of symptoms due to a rapid collection of fluid.

The advantages of siphon drainage are its ease and rapidity of application, the prevention of respiratory disturbance from the admission of air to the pleural cavity in those cases where adhesions have not formed, and the favoring of expansion of the lung as the fluid is evacuated. Furthermore, the child is kept dry, daily painful dressings are avoided and the emptying of the empyema cavity is under control of the surgeon. In certain instances the method is curative, in others it forms a valuable preliminary to subsequent measures. This form of drainage is indicated usually in infants under eighteen months, in older children whose condition does not warrant immediate rib resection, particularly where there is active pneumonia or other complication, in practically all empyemas due to the streptococcus and usually in those due to the staphylococcus group. During the first twenty-four to forty-eight hours the flow of pus may be interrupted at intervals by clamping the tube. The original tube will remain in place from four to seven days. If at the end of this period the discharge has become thin and scanty and slightly blood tinged, one may have hope of cure without further interference. In such cases the tube is removed and not reinserted, the wound is dressed daily and at intervals of two or three days a small catheter is inserted into the sinus to demonstrate and to relieve any re-

tention of exudate. If there is profuse discharge at the time the original tube is removed a short soft rubber tube is inserted and the wound dressed daily. If at the end of ten days to two weeks there is persistent profuse discharge or if at this period insertion of a catheter into the sinus demonstrates retention of exudate, resection of a portion of one rib is done if the condition of the child warrants it. If not, drainage is maintained as well as possible by a soft intercostal tube.

Open intercostal drainage is used in the same group of cases as is siphon drainage, when for any reason the latter is not applicable. Long-continued intercostal drainage tends to produce necrosis of the adjacent ribs, together with overgrowth of periosteal bone. This is one of its greatest disadvantages and may result in a persistent sinus.

Rib resection affords the best drainage and permits a view of the empyema cavity and opportunity for careful exploration if deemed advisable. The separation of adhesions in acute empyema is usually not indicated. Free exit is also given for the large masses of fibrin so frequently present in pneumococcus empyema. In suitable cases it is the ideal treatment. The site for rib resection depends, of course, on the location of the empyema, but most frequently the seventh or eighth rib in the posterior axillary line is chosen. As a primary procedure it is indicated in pneumococcus empyema in children over eighteen months who are in good condition and without active pneumonia. As a secondary procedure it is used following closed or open intercostal drainage which has proved inadequate. In treatment by any method, the most meticulous attention must be given to the daily dressings. Irrigation of the cavity in acute empyema in children is, in my opinion, not indicated.

It is the exceptional case which requires an emergency procedure for the evacuation of pus. At times, and particularly in streptococcus infection, the accumulation of fluid is so great and so rapid that there is mechanical interference with respiration. Under such circumstances prompt evacuation, preferably by aspiration or closed intercostal drainage, is indicated. An operation which results in an open pneumothorax will add greatly to the dangers of the situation. The advantages of a deferred operation are many. By the time the pneumonia has subsided and the exudate is frankly purulent, the diffuse inflammation of the pleura has become converted into an abscess, shut off, by adhesions, from the rest of the pleural cavity. The adhesions and inflammatory thickening of the mediastinum make it less mobile and an open pneumothorax has much less harmful effect.

Early diagnosis of the condition is undoubtedly desirable but repeated needling in a suspected case is to be deprecated. There is little to suggest in these cases that the spread of infection to parts remote from the lung—to the pericardium, the opposite pleura or the peritoneum—is to be attributed

to the presence of the empyema, or that an early or more radical operation might have prevented such an extension.

Bilateral empyema is more frequent in children than in adults. One side should be drained at a time, preferably by siphon drainage. A few days later the second side is drained in a similar manner. Subsequently rib resection may be undertaken if the intercostal drainage proves inadequate.

The general treatment of these patients is, I believe, fully as important as the local. One must never lose sight of the fact that the collection of pus

Fig. 142.—A Group of Children at the Rumsom Branch of the Babies' Hospital in New York, Convalescing after Operation for Empyema.

in the pleural cavity is in the majority of instances merely an incident in the course of a disease serious in itself and with a higher mortality of its own. It has been demonstrated in adults that a high caloric diet is desirable. It is none the less so in young children. Every effort should be made to have the nursing infant continue on the breast and the local treatment should be adjusted to meet this indication. Fresh air and natural or artificial heliotherapy are of the greatest importance. A few days after operation for empyema a child should have, in addition to the local treatment, about the same regimen as would be prescribed for a child of the same age who is subject of tuberculosis.

In many instances a transfusion of blood may prove to be the turning point toward recovery. During the acute stage and as long as there is any elevation of temperature absolute bodily rest is essential. Subsequently, blowing exercises, made interesting with colored fluid, balloons

or trumpets, and, in older children, carefully supervised calisthenics, aid in lung expansion and the avoidance of deformities.

**Tuberculous Empyema.**—This condition is rare in children, particularly so in the early years. Pneumothorax develops following the rupture of a tuberculous cavity and as such a cavity almost invariably contains pyogenic organisms the infection in the resulting empyema is of a mixed type.

Treatment is difficult and the outlook is poor. Where possible thoracotomy is to be avoided and some form of thoracoplastic operation in conjunction with repeated aspirations depended on to evacuate and obliterate the cavity.

**Chronic Empyema.**—The development of chronic empyema is relatively much less frequent in children than in adults. The common causes are:

1. Inadequate drainage
2. Foreign bodies (rubber tubes, etc.)
3. A cavity which has not been obliterated
4. Communication with the lung

A sinus may persist after the empyema cavity has been obliterated. This may be due to osteomyelitis of the cut end of a rib or to the formation of a ring of bone around the original sinus.

Before proceeding with further treatment an attempt should be made to ascertain the cause of the persistent discharge. Where osteomyelitis or overgrowth of bone is the cause, operation limited to the removal of the infected bone is sufficient. Where a cavity persists a portion of one or more ribs is resected, the cavity exposed, explored and any foreign body removed. Adequate drainage is provided and sterilization of the cavity is proceeded with after the method of Carrel-Dakin. This will usually suffice in children. If not, the more elaborate thoracoplastic operation must be considered. Decortication is not usually indicated or applicable in children.

## LUNG ABSCESS

Abscess of the lung may occur at any age and is more frequent in young children than is generally thought. It may be single or multiple but the latter type is rarely amenable to surgical treatment.

**Etiology.**—Pneumonia or other inflammatory lung conditions, the aspiration of foreign bodies or of blood or infective material during operations about the mouth and the occurrence of septic emboli, are the most important etiological factors. A lung abscess may result in exceptional instances from the extension of an empyema or hepatic abscess. The condi-

FIG. 143.—ABSCESS OF THE LEFT LUNG, PYOPNEUMOTHORAX, CHILD SEVENTEEN MONTHS OLD.

tion complicates pneumonia in infants more frequently than is generally supposed.

**Clinical Features.**—When an abscess is due to a breaking down of lung tissue after pneumonia, the condition is often mistaken for a developing

empyema. Cough is usually a distressing symptom and if there is drainage into a bronchus, the sputum is abundant and foul.

In other instances, at a varying period of from a few days to several weeks after tonsillectomy or other operation about the mouth or the aspiration of a foreign body, a persistent cough develops. There is usually some associated rise of temperature which may be constant at first and later intermittent. During the early stages the physical signs are indefinite. Later they vary according to the size of the abscess and whether it is near the surface or not. Often, about two weeks after the onset of symptoms, the sputum and breath are noted to be very foul.

**Clinical Course.**—The lesion may be near the hilum in the periphery of the lung or there may be multiple foci. It may be acute or chronic and in the latter case may be associated with bronchiectasis.

Healing of an abscess of the lung is the result of a process similar to that of the healing of abscesses in other situations. Following drainage the walls of the abscess collapse and there is gradual obliteration of the cavity. When this happens spontaneously healing may be very prompt. It is impossible to state in what proportion spontaneous healing occurs. Some authorities have estimated the proportion of such cures in postoperative lung abscess as about one in three. When such a fortunate result does occur it takes place usually within six or eight weeks and very rarely later than three months. The course of the disease when the abscess is a complication in pneumonia in infants is rapid, often results in pyopneumothorax and is usually fatal.

In the lung it is often difficult for the abscess cavity to become obliterated and the process becomes chronic. Furthermore, as a result of the inflammatory process the bronchi become dilated and a condition of bronchiectasis develops.

**Diagnosis.**—Physical signs taken in conjunction with the history and symptoms may suggest pulmonary suppuration, but it is rare indeed that a definite diagnosis is arrived at on the basis of physical signs alone.

Roentgenography is of value and often aids in localizing the lesion. Interlobar empyema and lung abscess may be confused. In the former there is a shadow extending across the entire chest on one side with radiolucent areas above and below. This shadow corresponds, in general, with an interlobar fissure. In lung abscess the shadow does not extend so far across, tends to be more irregular and is either partially or completely surrounded by a radiolucent zone. A radiopaque foreign body will, of course, be demonstrated.

The use of the bronchoscope is the most important aid in diagnosis. It is invaluable in differentiating other conditions and in addition often reveals not only the exact location but the character of the lesion. The examination

requires highly developed, specialized skill, and an extensive equipment. It is applicable in infants but should be made only by an expert.

When lung abscess is suspected exploratory puncture is only permissible in the presence of adhesions. This is on account of the danger of infecting the pleural cavity. It is better to undertake an exploratory operation than to run the risk of infecting the pleura.

**Prognosis.**—In infants the outlook is poor save in those instances where a foreign body is removed. In older children, the prognosis has improved with the development of precise methods of local examination and treatment and increasing conservatism in the use of surgical drainage. Graham recently referred to a series of forty children under twelve years in which the mortality was 12.5 per cent. In twenty-four of these cases only postural drainage and general measures were used.

**Treatment.**—A valuable prophylactic measure is the use of suction in all operations about the mouth to minimize the chance of aspirating blood or infective material. Before treatment is begun every effort should be made to locate the lesion and determine its character. The possibility of a foreign body must always be considered and its presence excluded. With the aid of the bronchoscope not only may a foreign body be removed but exudate which is stagnating in the bronchus be aspirated. As spontaneous drainage occurs into the trachea, posture aids in improving drainage and should be carried out three or four times a day. Many patients will recover without further surgical intervention. When, however, the condition progresses or does not improve under conservative measures surgical drainage must be considered. When the abscess is large and situated in the periphery of the lung the indication is clear. After resection of one or more ribs over the abscess, inspection and palpation will usually determine whether there are adhesions. If there are, a needle is introduced and if pus is obtained an opening is made by means of a cautery or knife into the abscess, using the needle as guide. If there are no adhesions the visceral and parietal pleura are sutured over a circular area or packing is introduced and the abscess is opened four to seven days later. These operations should, if possible, be carried out under local anesthesia. When open drainage is not feasible, as in some cases in which the abscess is at the hilum, artificial pneumothorax or thoracoplastic operations may be of value. The other more radical measures, such as lobectomy and cautery pneumonectomy, have given brilliant results in the hands of some surgeons. When the abscess ruptures into the pleural cavity and a pyopneumothorax results, drainage of the pleura may result in the prompt healing of the abscess.

The general treatment is fully as important in any case of pulmonary suppuration as it is in empyema and is carried out along the same lines.

## FOREIGN BODIES

**In Air and Food Passages.**—As a result of the habit which infants and young children have of putting small objects into their mouths, all sorts of curious foreign bodies find their way into the air or food passages. The accident is not uncommon and is frequently the result of avoidable carelessness on the part of the mother or nurse. This fact may have a bearing on the difficulty of obtaining the history. If such an object is being held in the mouth a sudden inspiration from any cause results in the body being drawn or falling into the open windpipe. This is true of the smaller articles; larger bodies, whistles, coins, etc., may cause choking but usually as a result of impaction in the esophagus, they being too large to enter the windpipe. The foreign body may lodge at the entrance to the larynx, in the ventricle of the larynx between the vocal cords or may pass into the trachea and on into a bronchus, most frequently the right. In any of these situations the body may be free or impacted and may cause more or less local damage or irritation according to its size and shape. The symptoms and results vary with the size, shape and composition of the offending body and its point of lodgment. The higher in the respiratory tract the body is lodged the more pronounced are the symptoms. On the contrary, the physical signs are more pronounced when the body is lower down in the air passages. In any event, at the time of the accident, the patient is usually seized with violent cough and dyspnea which are spasmodic and usually paroxysmal. When the point of lodgment is the trachea or bronchus after the initial choking and strangling there is a symptomless period and then bronchial symptoms develop. The initial choking may have been forgotten or may have escaped notice. It is surprising how readily parents and even physicians will assume that a foreign body which has disappeared from the mouth of a child has passed on into the stomach and out through the bowel. Every practitioner should realize in the case of aspirated foreign bodies that the initial symptoms even may be slight and that subsequently there is a longer or shorter quiescent period when symptoms are absent or so slight as to escape notice. Furthermore, the possibility of a foreign body in every respiratory disease which is characterized by unusual features should be kept in mind. Where there is a history of the aspiration of a foreign body and it cannot be located, it is well to remember that the article may lodge in the nasal chamber, nasopharynx, pharynx, esophagus, stomach or intestine or may have been passed by the bowel or coughed or spit out without the knowledge of the parent or nurse.

The diagnosis rests on history, physical signs and symptoms, the use of the Roentgen ray and endoscopic examination. The Roentgen ray is, of course, a most important means of diagnosis, but a large proportion of

bodies cannot be demonstrated by roentgenography. Early diagnosis is often essential to completely successful surgical treatment and there are many cases in which it is only by seeking the history and studying the signs and symptoms that such a diagnosis may be made. A number of pathological conditions may be confused. Among such are: Laryngeal diphtheria, spasmodic laryngitis, laryngismus stridulus, congenital laryngeal stridor, anaphylactic or thymic asthma, pertussis, papilloma of the larynx. The later results from the presence of a foreign body, bronchiectasis and pulmonary suppuration may be confused with tuberculosis or any form of chronic pulmonary suppuration.

The aspiration of certain organic bodies, notably peanut kernels, but also beans, seeds and the like, results in a severe inflammation of the air passages, toxemia, cough and fever. The younger the child the more severe is the reaction. These clinical features may suggest pneumonia. On the other hand, non-obstructing bone and metallic bodies, particularly the smaller ones, may remain with few or no symptoms for weeks and months, eventually resulting in a condition with signs and symptoms characteristic of a chronic pulmonary suppuration, abscess or bronchiectasis. The condition may simulate pulmonary tuberculosis but the apices are clear and the sputum is negative. The physical signs, chiefly those of partial or complete obstruction, vary in different cases and at different times in the same case. The most important signs are: (1) Limited expansion, (2) decreased fremitus, (3) impairment of percussion note. In some cases of complete obstruction with the lung filled with secretions, the absence of vocal resonance and fremitus cause the condition to be mistaken for empyema. Where obstruction is not complete râles may be most intense on the sound side. A foreign body lodged at the tracheal bifurcation may cause signs in both lungs. In the case of a body loose in the trachea certain signs have been described by Jackson as pathognomonic: "Audible slap," "palpable thud," "asthmatoid wheeze." In the case of a bronchial body there may be a symptomless interval followed by a cough, blood-stained sputum and the special taste or odor of the body may be noted. Non-obstructing bone and metallic bodies may afford few symptoms for weeks or months, whereas in cases of complete obstruction there result atelectasis, drowned lung and eventually pulmonary suppuration.

*Diagnosis.*—With a clear history and a foreign body demonstrable by roentgenography the diagnosis is clear. Where the history is lacking or indefinite and the body is not radiopaque, diagnosis may be very difficult. When the bronchus is completely obstructed the air contained in the alveoli becomes rapidly absorbed and there is collapse and subsequent waterlogging of that portion of the lung. When the body is so disposed as to allow the inward passage of air, but to obstruct its outlet, even when it is penetrated

by the Roentgen ray there may be characteristic and even definite roentgenographic evidence of its presence:

1. Greater transparency on the obstructed side
2. Mediastinum is displaced toward free side
3. Flattening of the dome of the diaphragm and limitation of its movements

The exposure should be made at the end of inspiration and again at the end of expiration. The former will evidence little difference in the two sides. This timing of exposure may be difficult or impossible in young children.

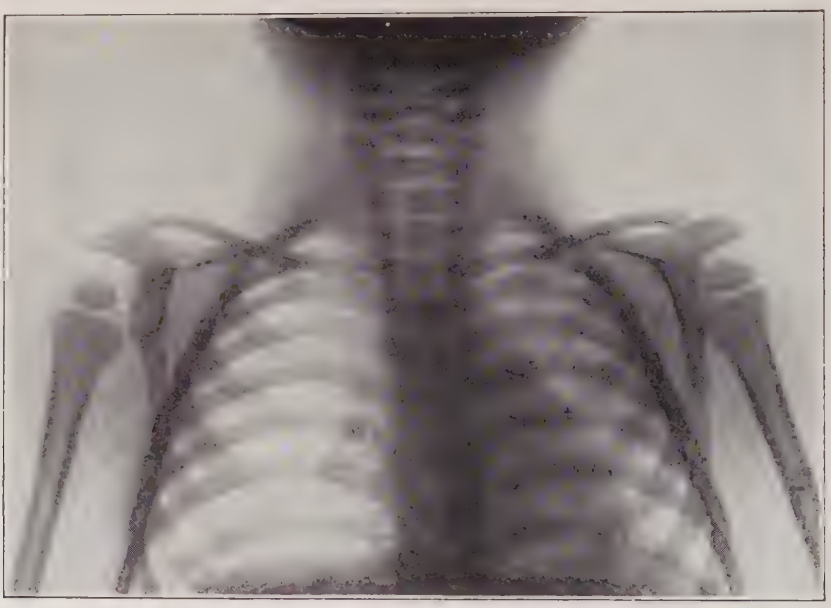

FIG. 144.—NON-RADIOPAQUE FOREIGN BODY IN RIGHT PRIMITIVE BRONCHUS. Note greater transparency on right side and flattening of dome of diaphragm.

The above signs which are present in the early stages are due to the presence of emphysema distal to the foreign body. Direct laryngoscopy in infants and young children, and indirect in older children, is a valuable means of diagnosis in the case of bodies lodged in the larynx. As in so many other conditions, if the possibility occurs to the examiner, a correct diagnosis will usually follow a careful examination. Even if the diagnosis cannot be made definitely, when there is a suspicion of foreign body a bronchoscopic examination should be made if an expert is available.

*Treatment.*—It is probably unwise to attempt to dislodge a foreign body with the finger, as often this serves only to push it further down. The

Fig. 145.—Open Safety Pin Arrested in Duodenum in Boy One Year Old.

time-honored maneuver of inverting the child and slapping him sharply on the back is also to be avoided as this may change the position of the body and aggravate symptoms. If suffocation is imminent tracheotomy is indicated. In cases where symptoms are less severe every effort should be made to place the patient in the hands of a doctor expert in the use of the bronchoscope. The development of the use of this instrument has been so great in the past few years that in the hands of experts practically any foreign body in the trachea or bronchi may be removed. In spite of the general belief to the contrary, the majority of accidents of this sort do not require precipitate haste in operating. This type of work is highly specialized, requires extensive equipment and should not be undertaken by the occasional operator save in a very definite emergency.

Aspiration of baby powders, notably stearate of zinc, is followed by rapid breathing, cyanosis and signs of bronchopneumonia. There may be sudden asphyxia with immediate fatal outcome. In other cases the acute symptoms last for two or three days and the condition gradually clears up. Treatment is symptomatic.

**In the Gastro-intestinal Tract.**—Foreign bodies, even of large size, when lodged in the esophagus may produce few symptoms at first but if not removed dangerous ulceration may follow. The most common and permanent symptom is interference with deglutition. If obstruction is complete or nearly so, a frothy secretion tends to collect and may overflow into the larynx, causing cough, huskiness and even pulmonary symptoms. There are commonly no symptoms while the body is in the stomach and it is usually true that any body which passes through the gullet into the stomach will pass through the pylorus. Pins and sharp objects may be arrested in the duodenum where it passes across the vertebral column. If the body passes beyond the duodenum it will almost certainly be passed out naturally.

*Treatment.*—A body lodged in the esophagus should, if possible, be removed with the aid of esophagoscopy. Very rarely esophagotomy is necessary. The removal of a foreign body from the stomach is scarcely ever indicated. If, however, the body is arrested in the duodenum for any length of time, operation is usually necessary. The passage of the body should be followed by means of the Roentgen ray and usually takes from forty-eight to ninety-six hours. It is quite astonishing to watch the harmless passage of an open safety pin through the intestinal canal. It is the exception when operative removal becomes necessary.

## SUPPURATIVE PERICARDITIS

Relatively few cases of suppurative pericarditis come to operation and yet the condition is not particularly uncommon. The disease is often

regarded as hopeless and one in which surgery is not indicated. It is well, therefore, to remember that in the reported cases in children operated on there were 50 per cent recoveries.

Infection may be by direct extension or through the blood stream. The pneumococcus is the organism most frequently found and the streptococcus is the next in order.

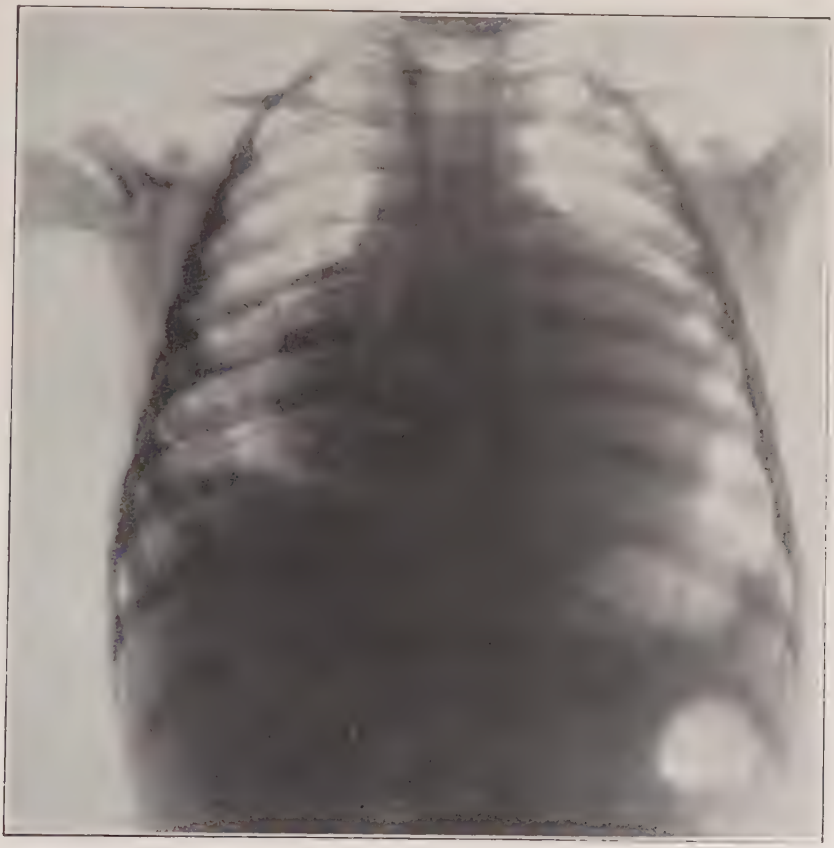

Fig. 146.—Pericardial Effusion in a Child Two and a Half Years Old.

Where there is only a small amount of exudate the symptoms are not characteristic. When, however, the pericardium is distended there is rapid pulse, dyspnea, restlessness and precordial or abdominal pain. As the exudate increases dyspnea becomes more marked, there is cyanosis and the pulse is rapid and irregular. The temperature curve is septic in type. The physical signs are those of pericardial effusion. Roentgenography is of great aid in diagnosis. When the condition is suspected the diagnosis should be confirmed and the character of the exudate determined by exploratory puncture. The needle is introduced through the left fifth inter-

space either close to the left margin of the sternum or 1½ inches from it (to avoid the internal mammary artery). Many other sites for the puncture have been advocated by different authors. When the fluid is thin the effect of aspiration may be watched. If frank pus is demonstrated, incision and drainage of the pericardial sac is indicated.

The operation should be done under local anesthesia. While the pericardium may be drained by an intercostal incision the best results are obtained by the wide exposure secured by resection of one or more costal cartilages.

Resection of the fifth left cartilage together with a portion of the sternum has been reported as giving adequate drainage. Pool suggests resection of the fifth, sixth and seventh cartilages. Drainage is secured by making a sufficiently large opening in the pericardium and suturing the edges to the skin. Irrigation after the Carrel-Dakin method has been advocated by some authors.

## MEDIASTINITIS; MEDIASTINAL ABSCESS

It is generally believed that the tissues in the mediastinum have little resistance to infection. When, however, it is realized that in many infections of the pleura and pericardium there must be at least some involvement of the adjacent mediastinum, it is evident that the susceptibility of these tissues is little if any greater than of similar tissues in a different situation. Mediastinitis may be acute or chronic and most commonly involves the anterior space. Simple, non-suppurative infection of these structures is probably not uncommon, associated with infection of the neighboring pericardium and pleura.

The acute suppurative type which is the most important may be due to the spreading of a deep cellulitis of the neck or may follow injury, especially of the esophagus and trachea or bronchi. In children the condition is usually met with as a complication of infective process in the pleura and pericardium. The infection may be phlegmonous and progressive or a localized abscess may develop.

The symptoms are varied; pain is referred to the front of the chest in involvement of the anterior mediastinum and to the back between the shoulder blades in that of the posterior space. Tenderness on pressure over the sternum may help to locate an abscess. There may be shortness of breath, irregularity of the heart and dilatation of the superficial veins over the front of the chest and root of the neck. The abscess may point in an intercostal space, usually near the sternum, or it may make its way into the esophagus or trachea, the pericardium or pleura. When the abscess is situated in the posterior space it may present in the supraclavicular fossa.

Diagnosis is extremely difficult and stereoscopic roentgenograms are of the greatest value.

Treatment consists in draining the abscess when possible; an anterior abscess may be reached by trephining the sternum or resecting one or more costal cartilages. An abscess situated in the posterior mediastinum and pointing above the clavicle, should be opened there. To reach the posterior space from behind it is necessary to resect a rib and its adjacent transverse process, preferably on the right side.

Among the commonest forms of disease of the mediastinal lymph glands is tuberculosis. Enlarged masses of glands may cause symptoms from pressure. Caseous or suppurating foci may discharge into the trachea, bronchi or blood-vessels.

## TUMORS OF THE MEDIASTINUM

Tumors of the mediastinum are relatively rare. Among the more common benign growths are the teratomata or dermoid cysts. While such tumors exist from birth their growth is slow and symptoms are not usually manifested until after childhood. Of the malignant tumors the most common are those originating in the thymus or in the lymph-nodes.

The symptoms and physical signs depend largely on the size and position of the tumor but in general are those of pressure, cough, dyspnea and, less frequently, pain. When there is obstruction to the venous return there may be dilatation of the superficial veins of the head and chest and cyanosis of the skin of that region. A roentgenogram reveals a non-pulsating spheroidal mass. The diagnosis of a dermoid is sometimes made as a result of rupture into the trachea or bronchi and the coughing up of hair and sebaceous material.

Extirpation is ideal but rarely possible. Even in the benign tumors incision and partial removal is usually all that can be done. Radiotherapy is indicated in the malignant growths.

## DIAPHRAGMATIC HERNIA

Diaphragmatic hernia is an evisceration of abdominal organs into the thorax through the diaphragm. The condition may be considered as being divided into three types: (1) Congenital, (2) acquired, (3) traumatic.

Both the congenital and acquired types are due to a defect in the development of the diaphragm. In the former the condition is present at birth, in the latter there is a gradual development of the hernia through one of the anatomic areas of least resistance. The diaphragm is built up of a number of different structures of muscular origin, is very complex in

development and there are apt to be defects where the different segments meet. Although a hiatus in the muscular structure may occur on the right side, the presence of the liver is sufficient to occlude it and the usual site of the hernia is on the left side.

The principal sites are:

1. The esophageal foramen
2. A triangular space between the sternal and costal portions of the diaphragm (Foramen of Morgagni)
3. The area between the lumbar and costal division (Foramen of Bochdalek)
4. The opening for the passage of the sympathetic cord

With small openings only a single coil of small intestine or a small portion of the stomach may form the contents. With large openings a considerable part of the abdominal contents may be in the thorax.

While it is usually the stomach and the organs anatomically connected with it which are in the hernia, all of the contents of the abdominal cavity, with the exception of the kidneys and pelvic organs, have been found above the diaphragm. The heart is displaced to the right and the involved lung may be rudimentary or collapsed.

Unlike other forms of hernia a true sac is absent in 90 per cent of the cases. This is due either to a failure of development of the peritoneum and pleura at the site of the hiatus or to the fact of the intimate adherence of the peritoneum and the muscular structures of the diaphragm.

Traumatic hernias are such as follow knife or bullet wounds of the diaphragm or crushing injuries with rupture. Of the traumatic variety it is practically the latter type only which is met with in children. It is well to remember the possibility of diaphragmatic hernia in children after crushing injuries when obscure symptoms, including abdominal pain, vomiting, cyanosis and dyspnea, supervene.

**Clinical Features.**—It is frequently difficult to classify the cases as to their origin and development. In the congenital hernias there are some which exist before birth, others in which only the hiatus in the diaphragm is present before birth and the prolapse of the abdominal organs into the thorax occurs at the time of delivery. In many such hernias the child is born dead or death occurs immediately after birth. However, the condition is not incompatible with life, and has been met with at all ages. In some, in spite of a gross evisceration, the condition produces no symptoms and is accidentally discovered. In others symptoms have existed since infancy. The symptoms are due chiefly to mechanical interference with the function of the organs herniated and to impairment of respiration and circulation.

FIG. 147.—PLAIN FILM OF DIAPHRAGMATIC HERNIA IN A CHILD ONE YEAR OLD.
(Case of Stafford McLean.)

They present the widest variation from mild digestive disturbances to an alarming interference with heart action, respiration and the function of the gastro-intestinal tract. There may be an entire absence of symptoms for

FIG. 148.—THE SAME PATIENT AS IN FIGURE 147 AFTER OPAQUE MEAL, SHOWING THE COILS OF SMALL INTESTINE IN THE CHEST.

years and then a sudden onset with either cardiorespiratory or gastro-intestinal symptoms predominating, or there may be a perplexing combination of the two. Symptoms of intestinal obstruction without abdominal

distention may feature the condition. The symptoms may vanish as suddenly as they appear. Gaseous distention of the stomach and the bowel may precipitate an attack. In the traumatic form as a result of crushing injury if the patient survives the immediate shock the symptoms may subside after a few days to reappear after weeks, months or years.

FIG. 149.—PHOTOGRAPH OF THE SAME PATIENT AS IN FIGURE 147.

**Physical Signs.**—The abdomen may be scaphoid with a corresponding fullness of the chest; on the other hand, there may be depression of the sternum. The heart is usually displaced to the right. Signs similar to those of pneumothorax may be detected in the chest and on auscultation gurgling in the stomach or intestine. The physical signs vary according to the extent of the hernia and from time to time in the same case. They

may not be the same at any two examinations, necessarily varying according to the contents of the stomach and bowel. At one time pneumothorax is simulated, at another fluid and again the signs indicate a combination of the two. The diagnosis may usually be definitely made with the aid of the proper use of roentgenography after an opaque meal. The position of the colon is defined with the aid of an opaque clysma. Stereoscopic pictures

FIG. 150.—SMALL DIAPHRAGMATIC HERNIA.

Hernia of a portion of the stomach through the esophageal opening of the diaphragm. Roentgenogram made with the child inverted.

may aid in localizing the hernial opening in the diaphragm and the relative position of the contained viscera. The use of the fluoroscope is of great value particularly in differentiating eventration or elevation of the diaphragm from the more common hernia. Probably the most important point in diagnosis is to have the condition in mind when the examination is made. It must be remembered that in an ordinary plate of the thorax the shadow

produced by a diaphragmatic hernia may be mistaken for a number of pathological conditions.

**Treatment.**—Surgery, of course, offers the only hope of a correction of the condition. In the presence of symptoms of intestinal obstruction operation is obviously indicated immediately. It is in those cases where the condition is discovered accidentally or where the symptoms are equivocal that the question is difficult to decide. In spite of the fact that normal health is possible in the presence of this condition in most cases the patient is more or less incapacitated. If operation is delayed until obstructive signs have appeared the operative mortality has been shown to be doubled. In children, in the congenital or acquired types where the evisceration involves the stomach and a considerable portion of the intestines, in the absence of symptoms it is wise to at least defer operation. Where there is herniation of a small portion of the stomach or where the stomach remains in the abdominal cavity and a portion of the intestine is herniated, in the presence of symptoms and in the absence of definite contra-indications, exploratory operation should be performed.

In 1925 Hedbloom was able to find only twenty-two cases in patients under twelve years in whom operation had been carried out. By many the condition is not regarded as amenable to treatment. However, as attention has been drawn to the relative frequency of the occurrence of this condition, particularly in the slighter degrees, it may be that operation will be more frequently advised and carried out. In the traumatic form operation is indicated as soon as the patient's condition warrants such a procedure. Certainly this is a condition in which greater familiarity with the natural history of the condition will afford greater opportunity for successful treatment. The choice between laparotomy and thoracotomy depends on the nature of the case. In obstruction laparotomy is indicated. In the ordinary case without obstruction thoracotomy seems to afford greater opportunity for closure of the hernial orifice.

## EVENTRATION OF THE DIAPHRAGM

Eventration or elevation of the diaphragm designates a condition analogous to paralysis of the diaphragm from injury to the phrenic nerve. The condition is probably congenital in origin and is due either to degeneration in the muscle-fibers, to insufficient muscular development or to nerve injury. There has been observed in fluoroscopic examination a typical excursion of one side of the diaphragm which differed from the opposite side only in being more restricted. Almost invariably the left side is involved. The diaphragm lies high with the stomach, spleen and large bowel occupying the space usually filled by the lung. Symptoms may be

absent and if present are referred either to the chest or abdomen. The clinical features resemble those of diaphragmatic hernia from which it may not be possible to differentiate it even with the aid of roentgenography. The continuity of the arch of the diaphragm in eventration, if possible of demonstration, serves to distinguish it from hernia. This condition is important to the surgeon only in its differentiation from diaphragmatic hernia as it is not amenable to surgical treatment.

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## CHAPTER XIX

## HERNIA; HYDROCELE; UNDESCENDED TESTIS

The two most important varieties of hernia to be considered in children are:

1. Umbilical hernia
2. Inguinal hernia

## UMBILICAL HERNIA

Umbilical hernia is common in infants. The usual type is not noted at the time of birth but manifests itself shortly after. There is, however, a certain type of umbilical hernia which exists at birth. This is called hernia into the umbilical cord, or exomphalos.

### Hernia into the Umbilical Cord

Hernia into the umbilical cord is the result of an arrest in development. In early fetal life the relative size of the umbilical cord is very great and it occupies a considerable portion of the space between the suprasternal region and the symphysis pubis. The greater portion of the small intestine lies within a cavity in the umbilical cord. Normally the intestine is withdrawn into the abdomen as the cavity in the cord, known as the umbilical celom, becomes obliterated. Any degree of arrest in development may occur from a cavity containing most of the abdominal contents to a small protrusion of peritoneum at the umbilical end of the cord.

**Clinical Features.**—The base of the umbilical cord is expanded into a cone-shaped enlargement varying in size and which is continuous with the abdominal wall. The walls of this enlargement consist for the most part of amnion and peritoneum and are so thin and translucent that the contents of the sac are readily visible. Small intestine is the usual content though a portion of the liver is not infrequently found. The omphalomesenteric duct may persist, in which case its attachment must be recognized and divided before complete reduction of the contents of the sac is possible.

**Treatment.**—Operation is the only treatment and should be undertaken as soon as possible after birth. In cases operated upon within a few hours, where complete reduction of the contents is possible, the outlook is excellent. Delay results in a drying out of the sac walls and adhesions

between the contents and the sac. The operation, which is carried out under ether anesthesia, consists in incision of the sac, reduction of its contents, careful ligation of the umbilical vessels and closure of the abdominal wall. If possible the edges of the umbilicus should be excised until only normal skin remains. It is usually sufficient to unite the edges with through and through sutures of silkworm gut.

Fig. 151.—Hernia into the Umbilical Cord, Baby Ten Hours Old.

### Amniotic Hernia

Where the development of the abdominal muscles is incomplete a portion of the wall may consist only of a membrane continuous with the amnion. This thin membrane may be stretched by the pressure from within to produce a protrusion which is called an amniotic hernia.

### Umbilical Hernia in Young Infants

This variety of hernia is common and occurs either as a protrusion through the center of the umbilical ring or, more commonly, immediately above it. It is usually noticed a few weeks after birth. In general the sac is small, non-adherent and easily reducible. There is no tendency to strangulation but, in rare instances, the condition may give rise to digestive disturbances. While primarily the result of a congenital weakness, any factor which increases intra-abdominal pressure or leads to imperfect support of the abdominal wall may aggravate the condition.

**Clinical Features.**—The protrusion at the site of the umbilicus is covered with normal skin and varies in size from that of a pea to a conical

swelling the size of half an orange. Even in the larger hernias the ring may remain small, the sac expanding on the surface of the abdominal wall. The contents are usually reducible and give an expansile impulse on crying.

Fig. 152.—Umbilical Hernia in a Boy Three Years Old.

Consideration of the possibility of cysts and tumors in the region of the umbilicus will usually serve to differentiate them.

**Treatment.**—Spontaneous cure may occur if the sac is small and reduction of its contents is maintained. The best method of maintaining reduction is with adhesive plaster, with or without a flat pad. The adhesive strap should be from 1½ to 2 inches wide and long enough to extend across the

abdomen. After the contents of the sac are reduced the umbilicus is cleansed and powdered, the skin inverted, and while maintaining this inversion the strap is carried across the umbilicus. Reduction is sometimes more easily maintained with a flat pad which may be made from a coin or button smoothly covered with adhesive. Where the skin is irritated by the adhesive a belt may be used but the pad should always be flat. If there is a projection which fits into the umbilical ring it will obviously prevent its closure. Reduction should be maintained while the strapping or belt is being changed. The results are excellent in the small hernias where careful treatment is carried out.

Radical operation is indicated when, for any reason, mechanical treatment has proved of no avail. If possible, reduction should be maintained until operation is carried out. However, in certain instances, the wearing of strapping or belt is so irritating to the skin that it cannot be continued. In general it is better to defer operation until after the child is three years old. Occasionally, because the hernia is rapidly increasing in size, or for other reasons, it is necessary to operate at an earlier age. The operation consists in an elliptical incision, including the umbilicus, deepened to the aponeurosis. The neck is isolated and the sac opened after reduction of its contents. If the peritoneum can be easily separated this is done and the peritoneal neck ligated after its edges have been freed from the abdominal wall. The circular ring in the muscular wall is converted into a transverse slit by lateral incisions and the ring margins are overlapped from above downward by means of mattress-sutures of twenty-day chromic catgut. The operation is not easy and should not be undertaken lightly. The wound should be supported by a firm pad and strapping for six weeks after the operation. The results, in general, are good. A third form of treatment has been practiced—subcutaneous ligature of the sac neck. I should personally hesitate to use this method.

## INGUINAL HERNIA

Inguinal hernia is the most frequent type of hernia met with in children. The essential factor in both hernia and hydrocele in early life is the persistence, in whole or in part, of a peritoneal process extending through the inguinal canal into the scrotum in the male, into the labium majus in the female. Whether this peritoneal process exists as the result of an actual descent or is due to an inequality of development is a question which it is not necessary for us to decide. Each theory has its supporters. Both the testis and ovary develop as intra-abdominal structures situated on the posterior abdominal wall behind the parietal peritoneum. There is a progressive shifting towards the iliac fossa. The ovary persists as an intra-

abdominal organ, assuming its normal adult position in the true pelvis just before puberty. The testicle normally migrates further, reaching the inguinal canal in the seventh, and the scrotum in the ninth month. Prior to the descent of the testicle a sac of peritoneum has extended through the inguinal canal into the scrotum. The distal portion envelops the testes and remains as the tunica vaginalis, but the proximal part normally disappears. An analogous peritoneal process in the female, known as the canal of Nuck, extends along the inguinal canal on the round ligament and into the labium majus. After the descent of the testis has been completed there is a progressive obliteration of the open peritoneal sac beginning at the internal ring and just above the testicle. Undoubtedly in a considerable number of children the peritoneal process is incompletely obliterated at birth and the natural tendency toward obliteration may continue for some weeks or months after birth. If, while the sac is open, its cavity is distended by intestine passing into it, the tendency to obliteration will be interrupted and a hernia determined. While the essential factor is a patent peritoneal sac, anything which tends to an increase in intra-abdominal tension may be a contributing factor.

FIG. 153.—VERY LARGE LEFT SCROTAL HERNIA, BOY ONE YEAR OLD.

**Incidence.**—The condition is more frequent in boys in the proportion of about nine to one. The hernia may appear at any period but the majority of cases are noted within the first few months of life. The right side is involved more often than the left.

**Varieties.**—In children a hernia is practically invariably of the indirect type, descending along the inguinal canal. In those rare instances where there is a direct sac protruding through the abdominal wall, medial to the deep epigastric vessels, there is an associated extroversion of the bladder. If the peritoneal process remains open throughout its extent, the contents will descend into the tunica vaginalis. This type of sac has unfortunately come to be known as congenital, a confusing term as the other varieties of sac as well are due to a congenital defect. The funicular type, in which the peritoneal sac has been shut off just above the testicle, is most common Other types of sac resulting from accidents of development such as the infantile and encysted need not be particularized here. The canal of Nuck occasionally remains open and is the seat of a hernia. The character of the sac wall varies, being usually very thin in so-called congenital herniæ and in all herniæ associated with undescended testicles but somewhat thicker in the funicular types. The neck is often indicated by a definite thickening in the wall of the sac and this thickening may recur at several points. The usual hernial content is small intestine. In females the ovary and fallopian tubes are not infrequently present.

**Signs.**—The signs are similar to those in an adult. There is a tumor with an expansile impulse on straining situated in the region of the inguinal canal. This swelling may be simply a bulge or it may extend down into the scrotum enveloping the testis. The swelling is reducible and reduction is accompanied by a characteristic gurgle. While the hernia may be noticed at birth, in the majority of instances it appears in the second to the fourth month.

It is unwise to disregard definite history of hernia on the basis of one physical examination. When the sac is empty it may be difficult to decide if a hernia exists. However, a careful examination of the cord usually enables one to detect some thickening. It is not infrequent, however, that a second or third examination is necessary.

**Diagnosis.**—There is usually little difficulty in recognizing as a hernia a reducible swelling in the region of the inguinal canal. When the sac is empty there may be difficulty, but usually an impulse on straining may be elicited or some thickening of the cord demonstrated. Where there is a definite circumstantial history of hernia the greatest care should be exercised in making a negative report on physical examination.

Certain conditions may be confused with hernia. Hydrocele communi-

cating with the peritoneal cavity is distinguished by the characteristics noted in the description of hydrocele. Hydrocele of the cord is distinguished from irreducible hernia by the character of the swelling which is firm yet elastic and fluctuant, and by the fact that a normal cord may usually be palpated above the swelling. There are, moreover, none of the signs usually associated with an irreducible hernia. It is well to remember, however, that an irreducible hernia in an infant may occasionally exist with no symptoms, the tense swelling being the only evidence of the condition. In the examination of every hernia it is essential that the scrotum be examined for the presence of the testes in normal position. The presence of an incompletely descended testicle in the inguinal canal may be confused with a hernia. In girls the hernia is usually small and frequently contains the ovary and fallopian tube. The hydrocele is tense and less tender. Enlarged glands in the inguinal region may be distinguished by their consistence and by the presence of some exciting cause.

FIG. 154.—BILATERAL SCROTAL HERNIA, BOY ONE YEAR OLD.

**Complications.**—Any complication is surprisingly uncommon in hernia in children. However, the hernia may become irreducible and in very rare instances may be strangulated. These accidents occur for the most part in the first year. Vomiting and constipation are usually present when there is strangulation. Any hernia which suddenly becomes irreducible and in which reduction is not easily accomplished should be treated as a strangulated hernia. There is a third complication—tuber-

culosis of the hernial sac which is usually associated with a tuberculous peritonitis. In girls, occasionally, the ovary in a hernial sac becomes torsioned with symptoms suggestive of an ordinary strangulated hernia.

**Treatment.**—Undoubtedly a certain proportion of hernias in infants disappear spontaneously without any treatment at all. This is particularly true in the rather frequent small hernias seen in badly nourished babies who subsequently take on weight and develop normally. It would seem reasonable to assume that often the failure of the peritoneal sac to close is due to retarded development only, and that, if favorable conditions exist, the obliteration will proceed to completion after birth and a spontaneous cure of the potential hernia result. The condition most essential is an empty sac and this is best insured by some form of mechanical treatment. When therefore, a hernia is recognized in an infant in the first few weeks of life and treatment is instituted which constantly maintains reduction of the hernial contents, a spontaneous cure may be expected in a certain proportion of cases. Mechanical treatment is not indicated in infants where there is simply a rounded protrusion in the region of the superficial ring and no tendency to extension into the scrotum. This is particularly true in badly nourished infants. The older the child when treatment is instituted, the less chance there is of cure without operation. In the case of a large hernia extending into the scrotum, where the sac communicates with the tunica vaginalis, there is little chance of a cure from mechanical treatment at any age. It is impossible to give reliable figures as to the percentage of spontaneous cures or cures from mechanical treatment. Furthermore "cures" may be temporary and a relapse of the hernia occur in after years. In considering the subject of the treatment of hernia it must be remembered that accidents are rare in young children and when a hernia is discovered in any child under two years of age, mechanical treatment should be instituted at once. As soon as possible a truss should be applied, but in many very young infants or in older babies whose nutrition is poor or whose skin is very tender, it is often desirable to begin with a yarn truss. In spite of the contrary opinion of many authorities, a yarn truss, properly applied, often serves an excellent purpose. A sufficient portion of four-ply white Berlin wool, varying in number of strands according to the size of the child, is obtained. The hernia is reduced, the loop of yarn hooked over the thumb, placed just above and external to the superficial ring. The other end of the wool is passed around the side of the hernia, across the back and around the front of the body to the starting point. The end is led through the loop, the loop adjusted and the end carried under the thigh and fastened in back. In most children after the first few weeks a truss is applicable and the best form is the cross body truss with a light spring covered with gutta percha

or hard rubber. A perineal band may be necessary. To measure for a truss for inguinal hernia pass a tape over the entire circumference of the pelvis from the spine of the pubis midway between the crest of the ilium and the trochanter major, a little higher in the back than in the front, to the point of origin. A diagram may be made by shaping to the above line two pieces of lead tape, fastened together in the back with a piece of adhesive plaster. The pattern may then be transferred to paper. The truss must fit well. It must be worn constantly night and day. It should be removed at the time of the bath, every care being taken to maintain reduction. The skin must be scrupulously clean and powdered. Only a light spring is necessary. Other types of truss may be used, provided reduction is maintained. If the truss is worn easily and maintains reduction operation may be deferred even after the second year but the hope of a cure lessens with each six months.

**Operation.**—There is no more satisfactory operation in surgery than that for cure of hernia in children.

*Indications for Operation.*—Operation is indicated at any age when there is a tendency for the hernia to become irreducible; when the truss does not maintain reduction; when the truss is intolerable; when the economic condition is such that proper care of the truss is unlikely. Strangulation is an absolute indication for immediate operation. If the infant is delicate and not thriving the operation should, if possible, be deferred. Also, operation may be deferred at the parent's wish if a well-fitting truss is worn. Every child in good health who has a hernia should be operated upon before going to school. Exception is made in certain cases of undescended testicle. I do not hesitate to operate at any age when there is a definite indication, but in general I prefer to wait until after two years.

*Procedure.*—The operation in infants is not easy and requires some experience. The essential feature is high ligation of the sac. If the distal portion strips easily, it is removed, otherwise it is left in situ. It is my practice to open the canal and, after the sac has been ligated, to place one or two sutures beneath the cord uniting Poupart's ligament to the internal oblique and transversalis. In infants under one year the operation is often limited to the high ligation of the sac. In children under two, I use a gauze and collodion dressing, first applying a thin coat of boric ointment to the wound. In older children a gauze and adhesive dressing is used. If the sac strips easily from the round ligament the operation is even simpler in females than in males. When there is difficulty in stripping the sac the round ligament is ignored and included in the ligation of the sac. Recurrence following operation for hernia in children is extremely rare.

## FEMORAL HERNIA

Femoral hernia is relatively very rare in children and almost invariably occurs in girls. The anatomy and pathology are identical with the same condition in adults and there is the same liability to strangulation.

**Diagnosis.**—The situation of the neck of the sac external to and below the spine of the pubis serves to distinguish the condition from inguinal hernia. Femoral adenitis may be suggested but the swelling in this condition is firm and unlike the elastic feel of an irreducible hernia and does not give the expansile impulse of a reducible hernia.

**Treatment.**—Operative treatment is indicated unless there are very definite contra-indications.

**Operation.**—The low operation is preferred save where there is strangulation when the approach should be made through the inguinal canal. High ligation of the sac is an adequate curative measure.

## VENTRAL HERNIA

Under this term are included protrusions through the anterior abdominal wall other than at the inguinal, femoral or umbilical rings.

**Diastasis of the Recti Muscles.**—In young children, particularly in those who have rickets, there may be a longitudinal protrusion above the umbilicus due to wide separation of the recti muscles. In pronounced cases an abdominal belt may be worn. No other treatment is indicated as the condition will be corrected in the process of growth.

FIG. 155.—VENTRAL HERNIA AS A RESULT OF PARALYSIS OF THE MUSCLES OF THE ABDOMINAL WALL.

A sequel of anterior poliomyelitis.

As a result of interference with nerve supply or of congenital defect in the broad muscles of the abdomen a more or less localized bulging may occur. An abdominal belt should be advised in such cases.

*Postoperative ventral hernia* may be found at any part of the abdominal wall that is the seat of a scar. Such hernias most often occur in wounds which have suppurated but may be found where there has been no obvious interference with healing. In infants there is a very definite tendency for such hernias to disappear in the process of growth with aid of a belt or of careful strapping. In older children there is less tendency to spontaneous cure and operative repair is usually indicated. If the hernia occurs in the scar of an infected wound such repair should be delayed for at least six months after the original wound has healed to avoid the likelihood of lighting up a latent infection.

## EPIGASTRIC HERNIA

Epigastric hernia is met with near the midline above the umbilicus. Usually there is merely a protrusion of properitoneal fat without a definite sac. The protrusion occurs through a small transverse slit in the fascia and is almost invariably at the site of exit of a blood-vessel. The symptoms may be out of proportion to the apparent pathological condition. There may be pain and tenderness accompanied by nausea and vomiting. If such symptoms exist operation is indicated as there is no tendency to spontaneous cure.

Operation consists in excision of the fat pad with careful ligation of the neck and accompanying blood-vessel. A single mattress-suture serves to close the slit in the fascia.

## HYDROCELE

An accumulation of serous fluid in some part of the processus vaginalis constitutes a hydrocele.

**Varieties.**—In the congenital type the peritoneal sac is patent throughout and there is a communication with the peritoneal cavity too narrow to permit the prolapse of intestine but of sufficient caliber for the passage of fluid. This sac, distended with fluid, forms what is known as a congenital hydrocele. There is present a tumor extending from the bottom of the scrotum throughout the whole length of the inguinal canal. This tumor is sometimes reducible by position but when the opening is smaller by pressure only. The tumor is translucent and is flat on percussion. While the contents may be gradually reduced, reduction is never accomplished suddenly and completely as may be the case in hernia. Hydrocele of the tunica vaginalis is the most frequent form and is limited to the tunica, the remainder of the processus vaginalis having been obliterated. There is an oval tumor, tense, firm and translucent, occupying the scrotum.

Hydrocele of the cord is the distention of a localized area of the peritoneal sac along the cord. An analogous condition occurs in females and is known

as a hydrocele of the canal of Nuck. There may be several such areas separated by narrow intervals.

**Treatment.**—In the common hydrocele of the tunica vaginalis occurring in infants there is a great tendency to spontaneous disappearance. There is no indication for local applications. If the tumor persists and is increasing in size it may be aspirated by means of a thin hypodermic needle. If the condition persistently recurs a few drops of 95 per cent alcohol may be injected after aspiration. In those hydroceles connecting with the peritoneal cavity operation is indicated but may usually be deferred until the child is two years old. Hydrocele of the cord often disappears spontaneously, but if not may be operated upon at a convenient time but should not be aspirated for fear of puncturing a vein.

## IMPERFECTLY DESCENDED TESTIS

The testis, developed from the genital eminence, lies at first below and behind the kidney. The space between the testis and the kidneys increases as the fetus grows and by the end of the sixth month the testis approaches the pelvic brim. During the seventh and eighth month the testis occupies the inguinal canal, reaching the bottom of the scrotum by the middle of the ninth month. The change in position is probably partly due to inequality of development, the inguinal canal growing up and surrounding the testicle, and partly to the influence of the gubernaculum. The gubernaculum, a muscular structure which atrophies after the descent of the testicle, is attached above to the testis and epididymis. Its lower attachments are widespread, the major portion of its fibers pass down to the bottom of the scrotum; other bundles pass to the lower margin of the abdominal muscles in the region of the inguinal canal; to the deep fascia near the saphenous opening; to the perineum close to the anus. When the guiding action of the band extending into the scrotum predominates the testis passes to its normal position. It may happen, however, that one of the other bands controls the migration of the testis and it passes into an abnormal position constituting a misplaced or ectopic testis. The terms inguinosuperficial, crural and perineal are used to describe these three common forms of ectopia. Often the descent may be retarded, the child being born with one or the other testis within the abdomen or inguinal canal. In the greater number of these cases descent is completed within a few weeks or months after birth, in some not until the approach of puberty. In a certain proportion of cases the testicle is felt at the external ring and by traction can be brought down into the scrotum. In such cases it may be confidently expected that by or shortly after puberty the testicle will reach its normal situation. One or both testes may be permanently retained in the abdominal cavity (cryptor-

chidism). It is very rare to find the testis in its original position behind the kidney, the usual situation being within the deep inguinal ring. When the gland is arrested at any point in the inguinal canal it is described as an imperfectly descended testicle. The terms abdominal, inguinal, pubic or upper scrotal may be used.

Fig. 156.—Undescended Left Testis, Boy Four Years Old.
Note lack of scrotal development.

**Clinical Features.**—The various abnormalities are usually unilateral and occur more frequently on the right side. The condition is said to occur once in one thousand male children. The scrotum on the affected side is often undeveloped. The gland may be recognized by palpation and it may be possible to push it back into the abdomen or down into the scrotum.

It is commonly smaller and softer than normal and testicular sensation is present. When the condition is bilateral and the glands are imperfectly developed there is usually interference with physical growth and often evidence of a reversion to feminine type. When one testicle is fully developed and normally placed, masculine characteristics are retained and the patient has full sexual power. In bilateral cryptorchidism the patient is usually sterile and may be impotent. There are, however, cases on record in which the undescended testes are said to have attained their full development and the patient to have been apparently fertile. However, spermatogenesis is unusual and probably occurs in less than 10 per cent of bilateral cryptorchids. The tendency to abnormality is greatest in abdominal testis. An ectopic testis, and this is particularly true of the perineal form, is likely to approximate normal size and development. Moore's experiments afford evidence that temperature regulation is necessary for the primary function of the testis and that the function of the scrotum is that of a heat-regulating mechanism. In general, full descent is necessary for perfect development. There seems to be a greater tendency to malignant growth in undescended testes.

In the greater number of undescended testes there is an accompanying hernia, the sac being usually of the congenital type. The hernia may be large or small, but not infrequently is so small as to give no clinical signs. Hernia is frequently associated with an ectopic testis but the condition is not nearly so invariable as when there is incomplete descent.

**Treatment.**—The treatment should be operative and trusses avoided. There is some subtle influence which interferes with the full development of a testicle until it has fully descended. The question resolves itself in choosing the appropriate time for operation. In the first place, in those cases in which the testicle is in the inguinal canal, low down, or in the upper part of the scrotum, it is better to wait until the approach of puberty as there is a reasonable chance of normal descent. This is not true in the inguinosuperficial type which is common and in which the testicle has come out of the superficial ring and ridden up on the aponeurosis of the external oblique.

In general operation should take place between the ages of four and twelve, the best time being from the sixth to eighth year. However, in the presence of complicating factors such as a large, troublesome hernia or recurring injury to the organ, operation should be undertaken whenever the child is in good condition. It is better to place the undescended testicle in the scrotum even if atrophy does occur.

**Operation.**—Operation consists in exposure of the testis and cord, freeing the cord of all bands and adhesions and stripping the vessels up as far as possible behind the peritoneum. Any hernial sac present is

isolated and ligated after the cord has been freed. The most careful attention is given to preserving the circulation of the testis as interference with the blood supply will almost inevitably result in atrophy. By careful attention to detail the cord may usually be lengthened sufficiently to allow the testicle to be placed in the scrotum without cutting the veins. This latter

Fig. 157.—Unusual Congenital Malformation of External Genitals in a Boy Thirteen Years Old.

procedure may almost always be avoided. Fixation of the testicle by means of suture is not successful. When fixation seems indicated the operation of Torek or the transscrotal operation of Ombudanne must be considered. In closing the inguinal canal the cord is not transplanted above the internal oblique. It is, in my opinion, wiser to operate on one side at a time. There is often considerable ecchymosis of the scrotum after the operation. This requires no treatment and disappears rapidly.

Results vary according to the degree of descent and to the condition of the testis. If the circulation is not interfered with and the testis is not abnormal, three out of five cases should show a good result; that is, the testis remains in the scrotum and develops normally. When the testis is atrophic the chances are much against its complete development. Where there have been recurring attacks of inflammation, atrophy is almost certain to occur. In my own experience the higher the testicle the greater chance there is of atrophy. In ectopic testicles the outlook is better as there appears to be less tendency to abnormality in the gland.

## TORSION OF THE CORD

Torsion, or axial rotation of the cord, may occur in the case of a normally situated testis but is more frequent in instances of abnormal descent. There is a sudden severe pain in the region of the testis, sometimes referred to the lumbar region. There is local tenderness and nausea or vomiting, the patient is faint, temperature may be raised and the pulse rate increased. There is swelling of the testis, effusion of fluid and later redness and edema of the skin. The condition most often confused with torsion of the cord is strangulated hernia. Indeed, the two conditions may coexist. Acute inflammation of a retained testicle, either traumatic or gonorrheal, may be confusing. Inguinal lymphadenitis is another condition to be kept in mind. Occasionally the condition has been mistaken for appendicitis. The treatment is surgical and consists in exposing the organ and restoring the normal relations if the testis appears viable. If the condition has existed as long as twenty-four hours the testis is usually so damaged that it will be necessary to remove it.

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# CHAPTER XX

## SURGERY OF THE ABDOMEN

Certain surgical conditions within the abdomen owe their origin to developmental errors. In the early weeks of fetal development the primitive alimentary canal is continuous with the yolk sac. As growth proceeds the subdivision of this canal into foregut, hindgut and midgut becomes apparent. The pharynx, esophagus, stomach and that part of the duodenum above the papilla of Vater, as well as those organs formed as outgrowths, are developed from the foregut. The blood supply is derived from branches of the celiac axis and the function is digestive. The large intestine from about the middle of the transverse colon to and including the rectum is developed from the hindgut. The blood supply is derived from the inferior mesenteric vessels and the function is largely excretory. Between these two portions is the midgut from which is developed all the small intestine below the papilla and the large intestine to the middle of the transverse colon. The superior mesenteric artery furnishes the blood supply and the function is that of absorption.

The midgut grows very rapidly, forming a large loop which on account of the rapidly increasing size of the liver cannot be accommodated within the abdominal cavity and is therefore extruded into the umbilical cord, forming a temporary physiological umbilical hernia. The communication between the midgut and the yolk sac becomes narrowed and constitutes the omphalomesenteric duct. This duct in normal development disappears very early but a remnant may persist in the form of a Meckel's diverticulum. The midgut undergoes rotation in such a manner as to bring the large intestine across the duodenum and the cecum to the right until it lies just below the liver. Later the cecum descends to occupy its normal position in the right iliac fossa. Under normal conditions the herniated midgut is returned into the abdominal cavity by the end of the tenth week. As the cecum descends into the iliac fossa certain portions of the intestine become fixed by fusion of their mesenteries with the posterior parietal peritoneum.

## DEVELOPMENTAL ERRORS OF THE GASTRO-INTESTINAL TRACT

**Esophagus.**—There may be local arrest of development, usually in the lower portion resulting in stenosis. In other cases a portion of the esophagus

Fig. 158.—Congenital Atresia of Esophagus, Infant Eight Days Old.

is entirely absent or is represented by a fibrous cord. Of the latter deformity there are two types: In one, which is so rare as to be exceptional, a portion of the gullet is represented by a fibrous cord but there is no communication with the trachea; in the other and more frequent type, the upper esopha-

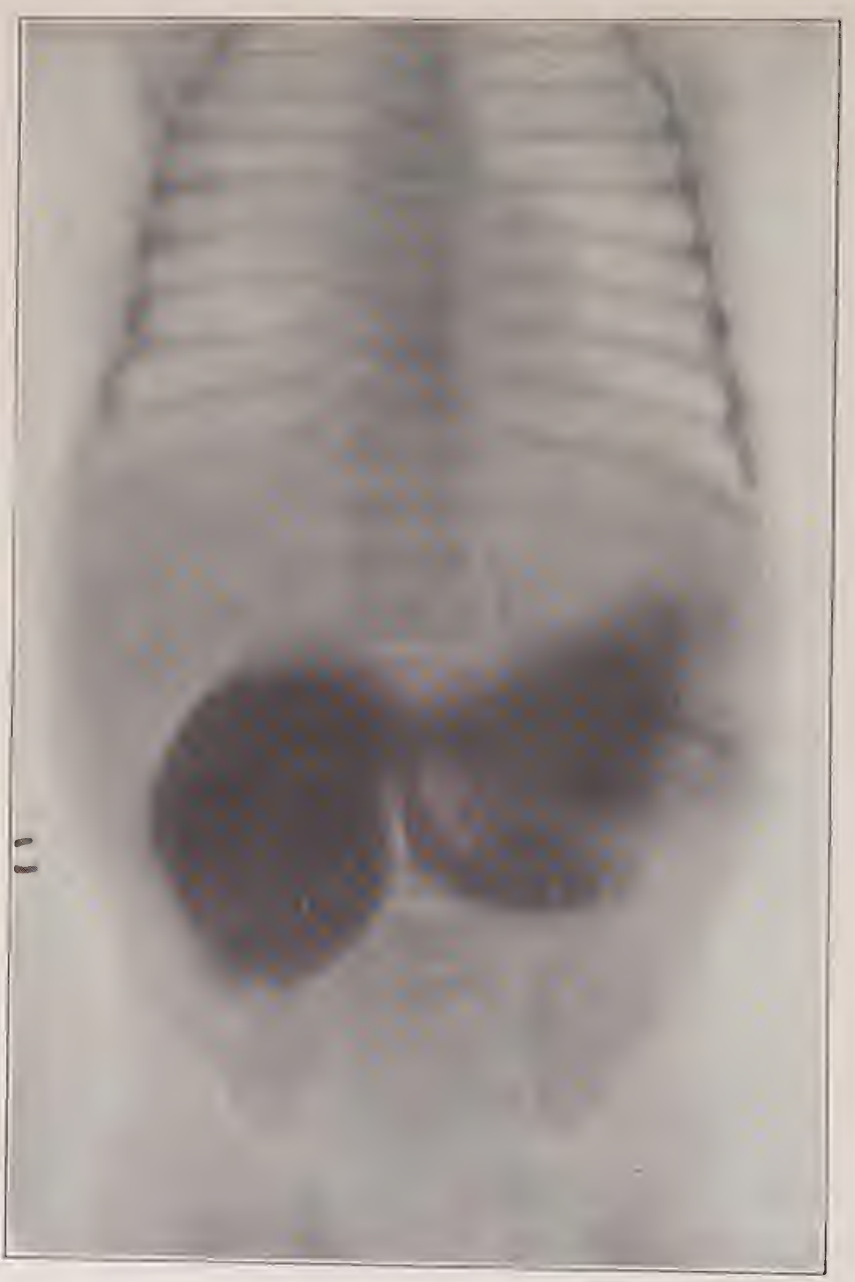

FIG. 159.—COMPLETE CONGENITAL OBSTRUCTION OF DUODENUM.
Roentgenogram six hours after opaque meal in an infant eight days old.

gus ends blindly while the distal portion opens into the trachea at its bifurcation.

*Clinical Features.*—In the case of stenosis there may be regurgitation of food from birth or the trouble may not appear until the child begins

to take solid food. The narrowing is made out by the passing of a bougie or by a roentgenogram after the swallowing of an opaque meal. The degree of interference with development is dependent on the amount of food which gets past the narrowing. When there is difficulty in swallowing and no history of the ingestion of caustics it is well to remember that congenital stenosis does exist. The diagnosis may be delayed and I know of one instance where the child was treated as a "neurotic" for a long period before the condition was finally recognized.

When there is obliteration the child has from birth been unable to nurse. There is profuse salivation. The vomiting which occurs after a few mouthfuls of milk have been swallowed is accompanied by dyspnea and cyanosis. When an attempt is made to pass a catheter or bougie it is arrested, usually at about the level of the bifurcation of the trachea.

*Treatment.*—When there is a stenosis gradual dilatation should be attempted. A temporary gastrostomy may be indicated if the condition is poor and even when the condition is good may prove a valuable adjunct to treatment. In the case of obliteration no treatment is of avail but the intense thirst may be somewhat alleviated by hypodermoclysis. I have on several occasions done a gastrostomy and in one instance ligated the cardiac end of the stomach to prevent regurgitation from the stomach through the lower esophagus into the air passages. This measure holds out no prospect of success and I now advise against any operation.

There may be congenital diverticula of the esophagus which in clinical features differs in no respect from the acquired type in adults.

**Intestines.**—Congenital stenosis or atresia may occur at any point in the small intestine. There may be complete absence of a segment, a portion of the bowel may be replaced by a fibrous cord or there may be a septum partially or completely occluding the lumen. The lumen may be replaced by a minute tract. The defects are frequently multiple. The most frequent site is at the beginning of the midgut just above the opening of the papilla of Vater. Stenosis or atresia in the large intestine is very rare and usually occurs in the region of the splenic flexure. It is well to bear in mind that what appears to be an ordinary case of imperforate anus may also show one or more areas of intestinal atresia. In a case of imperforate anus where the intestinal contents are gray and pasty it is reasonable to assume that there is obliteration of the intestinal lumen higher up and below the opening of the bile-duct.

*Clinical Features.*—When the obstruction is in the duodenum, vomiting is noted from birth but not necessarily after every meal. If the obstruction is above the opening of the bile-duct there is no bile in the vomitus. Meconium stools will be passed and the character of the stools will not

change though the quantity may be diminished. A roentgenogram made after an opaque meal will reveal the site of the obstruction and the enormously dilated duodenum. When the obstruction is not complete the character of the stools changes and vomiting is not so persistent. Peri-

FIG. 160.—ROENTGENOGRAM SHORTLY AFTER OPAQUE MEAL IN THE SAME PATIENT AS IN FIGURE 159, TWO MONTHS AFTER ANTERIOR DUODENOJEJUNOSTOMY.

This patient is now twenty-two months old and is well developed and nourished.

staltic waves may be made out. These cases are differentiated from congenital stenosis of the pylorus by the early symptoms, roentgenogram and the absence of pyloric tumor. Any baby vomiting persistently from birth merits prompt investigation by means of an opaque meal. When the obstruction is in the small intestine, vomiting may be delayed for one or more days, after which time it is persistent and the vomitus becomes feculent.

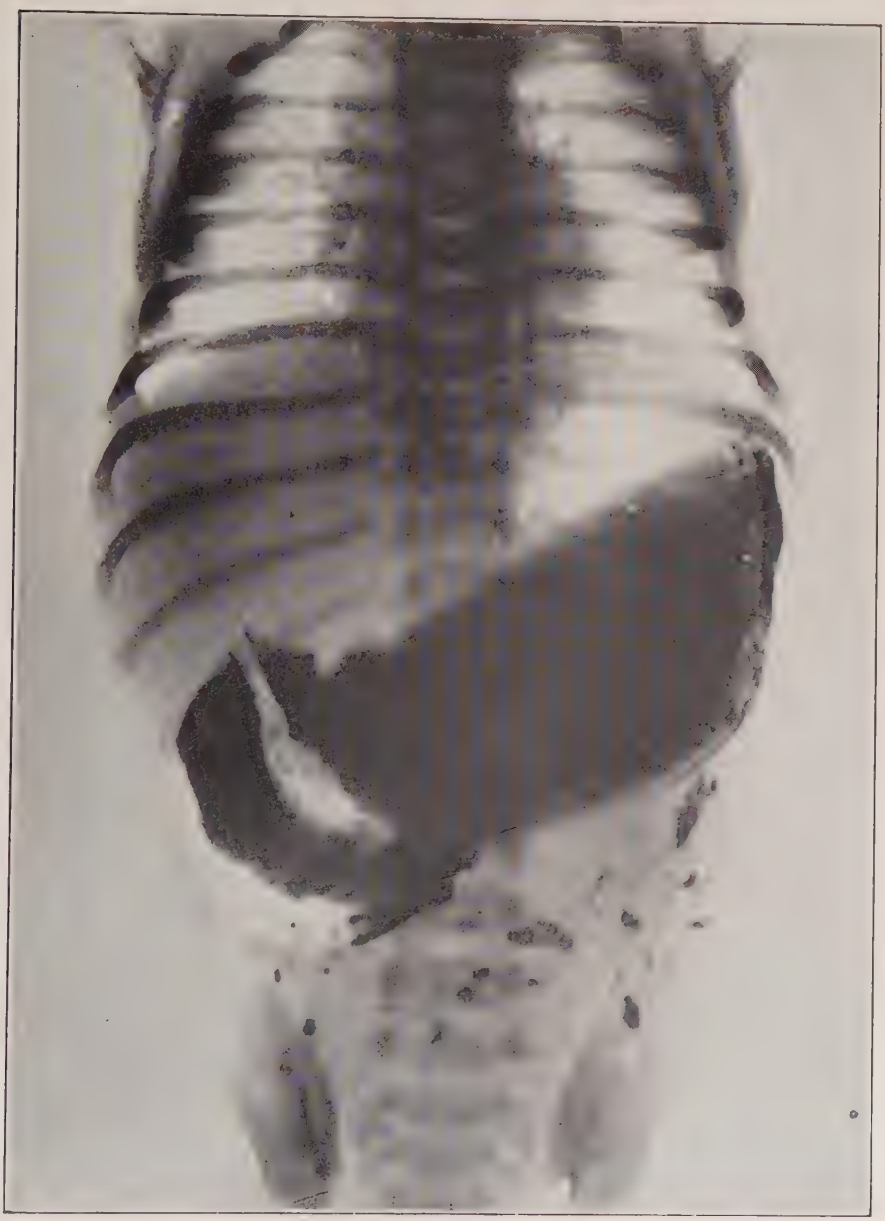

Fig. 161.—Congenital Stenosis of the Duodenum Four and a Half Hours after Opaque Meal in an Infant Fourteen Days Old.

abdominal distention is marked and there is absence of stools or the character of the stools differs from meconium and they are gray and pasty.

*Treatment.*—Operation offers the only hope of relief and should be undertaken at once. In the high duodenal obstruction a duodenojejunostomy offers the best outlook. In certain instances it is scarcely possible

FIG. 162.—SAME PATIENT AS IN FIGURE 161 FIVE MONTHS AFTER POSTERIOR DUODENO-JEJUNOSTOMY.

Roentgenogram after opaque meal. This patient is now ten months old, well developed and nourished.

to carry out the usual operation posterior to the colon and an anterior operation uniting the jejunum about 10 centimeters below the angle to the duodenum and in front of the colon is the operation of choice. In

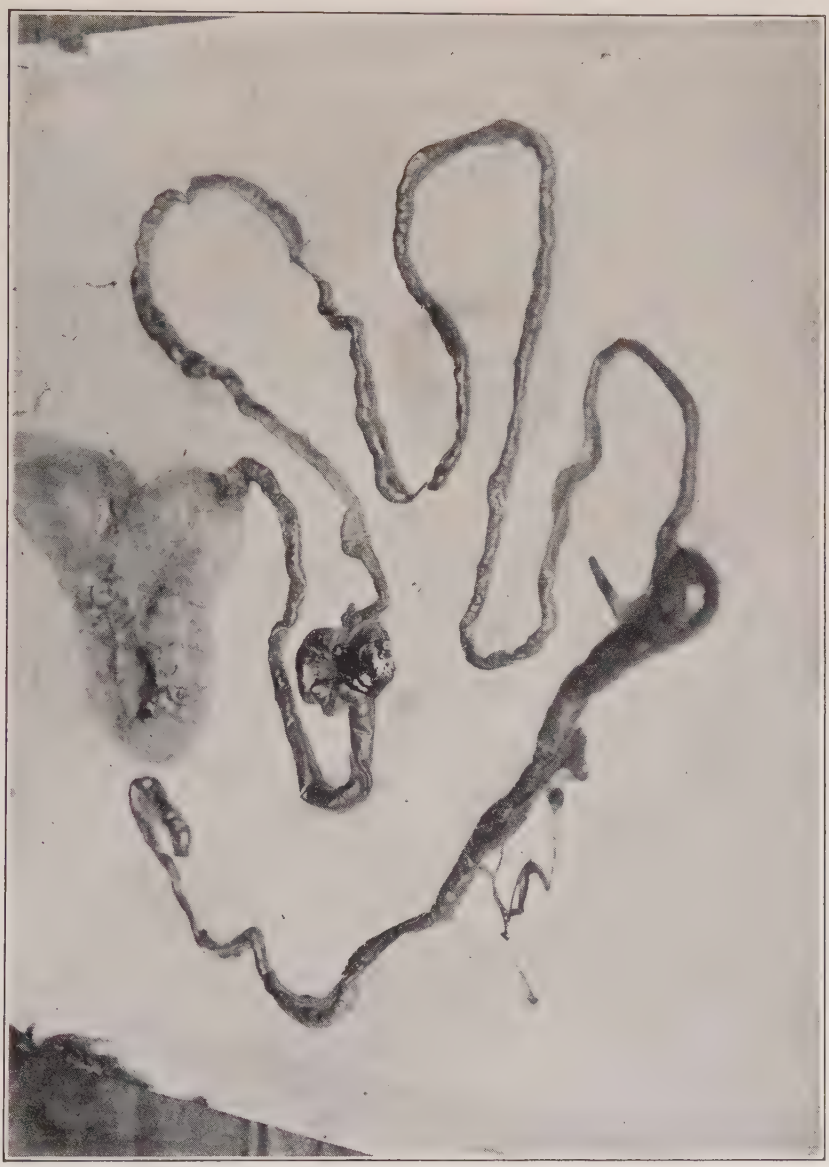

FIG. 163.—MULTIPLE ATRESIA OF THE INTESTINE.
Specimen removed at autopsy in baby three days after birth.

other cases the usual posterior operation is applicable. A posterior gastro-enterostomy is less desirable. When this condition is kept in mind and an early diagnosis is made there should be a reasonable proportion of cures. I have operated on three such cases of congenital obstruction of the duodenum with two successful results.

Where the obstruction is lower down in the jejunum or ileum some

form of entero-anastomosis is the operation of choice. There has been at least one successful result from this type of operation. Unfortunately these patients usually reach the surgeon so late and with such enormous distention that the only practicable operation is an external enterostomy. This has been uniformly unsuccessful. It is not reasonable that the mortality in these babies should continue at practically 100 per cent. There is a certain proportion of cases in which the condition is such as to lend itself to surgical relief if the diagnosis is made before the patient is moribund.

**Congenital Diverticula.**—Congenital diverticula may occur in any portion of the intestinal tract, most commonly in the duodenum, lower ileum and large intestine. Their discovery in childhood is usually accidental. There is one exception. In about 2 per cent of human subjects a remnant of the intra-abdominal portion of the omphalomesenteric duct persists forming a congenital abnormality known as a Meckel's diverticulum. This remnant usually springs from the antemesenteric border of the ileum about 2 feet from the ileocecal valve, and its structure is similar to that of the lower ileum. It may be accompanied by a remnant of the vitelline artery running in a mesentery attached to the diverticulum. In the greater number of cases it exists as a conical projection, free in the peritoneal cavity, and produces no symptoms.

The varieties depend upon the stage at which the obliteration of the vitelline duct has been arrested and give rise to a diversity of surgical conditions. Those conditions arising when the duct is pervious and attached to the umbilicus have been described with the diseases of the umbilicus. The diverticulum may be attached to the abdominal wall at the site of the umbilicus or it may have formed a new attachment. In either case there is a band in the peritoneal cavity which may result in intestinal obstruction. Infective lesions may occur and give rise to symptoms in every way similar to appendicitis. Rarely the diverticulum may become inverted and form the apex of an intussusception. The discovery of a Meckel's diverticulum is always either accidental or a result of complications.

In the course of an operation to relieve intestinal obstruction or diverticulitis due to a Meckel's diverticulum, the diverticulum should be removed if possible. When the condition is met with in the course of another operation the diverticulum should be removed only if such a procedure will not unduly prolong or complicate the original operation.

**Congenital Volvulus.**—As a result of errors in rotation volvulus may occur, practically always in relation to the midgut. There may be non-rotation, in which case the small intestine lies chiefly to the right of the midline and the cecum is in the midline or even in the left iliac fossa with the ileum entering from the right side. Various irregularities of normal rotation may occur. In each error the essential feature is that the whole

midgut loop is suspended by a narrow pedicle which renders it liable to undergo rotation resulting in volvulus and high intestinal obstruction. Acute intestinal obstruction occurring in a baby a few days after birth suggests congenital volvulus.

*Treatment.*—The only treatment is surgical and should consist in replacement of the rotated loop to as near normal relations as is possible. Occasionally it may be feasible to secure the intestine in its proper position by a few sutures to the posterior abdominal wall. Gastro-enterostomy does not seem to meet the indications.

## AFFECTIONS OF THE UMBILICUS

Early in fetal life the intestine adheres to the umbilicus by the omphalomesenteric duct. Later this connection disappears and the intestine be-

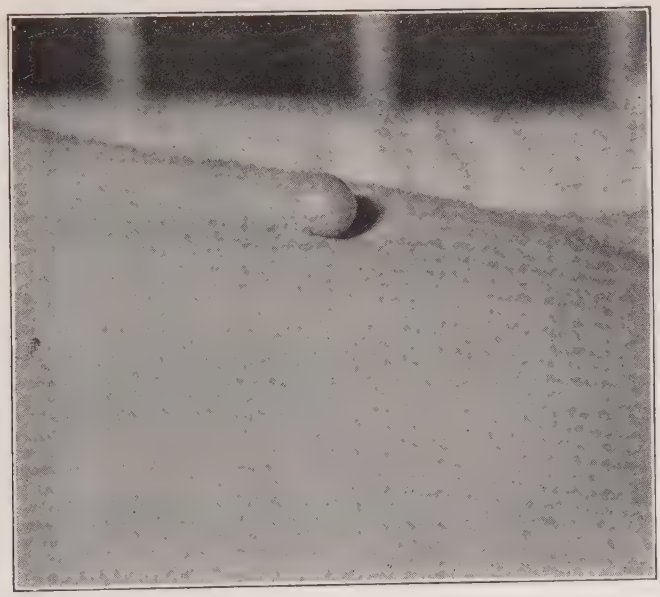

Fig. 164.—Epidermoid Cyst of Umbilicus in a Boy Eight Years Old. (Case of Wm. F. McFee.)

comes free in the peritoneal cavity. Certain malformations result from the incomplete disappearance of this duct. The most frequent is the persistence of a diverticulum (Meckel's) attached to the convex border of the small intestine about 2 feet from the ileocecal valve and free in the peritoneal cavity. If a diverticulitis occur it may simulate an appendicitis or the tip of the diverticulum may adhere to some adjacent structure with a resulting intestinal obstruction. The duct may remain attached

to the umbilicus, thus producing a band through the peritoneal cavity which may also result in intestinal obstruction.

**Fistulæ, Cysts and Adenomata.**—There are many varieties of this condition. The duct may remain open throughout and when the cord has separated there remains a red tumor at the umbilicus, in the center of which is a fistula from which there is a discharge of mucus. Very rarely a true fecal fistula is found. If this condition persists there may be a prolapse of mucous membrane. If the duct is shut off at either end a cyst may result which may be either on the inner surface of the abdominal wall or

Fig. 165.—Granuloma of Umbilicus, Infant Seven Months Old.

between the skin and the aponeurosis. There occasionally occur solid tumors in the umbilicus arising from the remains of the duct which histologically are adenomata. They are bright red, resemble intestinal mucous membrane and secrete clear mucus.

*Urachal Fistulæ.*—If the urachus, a cavity in the stalk of the allantois, remains patent, there results a fistula between the bladder and the umbilicus. There is either a small area of granulation tissue or a fissure in the umbilicus from which urine drips. Suppuration may occur in a patent urachus. There is a purulent discharge from the umbilicus, the urine is loaded with pus and there may be a phlegmonous inflammation of the abdominal wall.

Diagnosis.—The most common condition met with in the region of the umbilicus is the ordinary granuloma which persists after the cord

has separated. They are pale and flabby, discharge mucopurulent material and have no lumen. Omphalomesenteric fistulæ are distinguished by the presence of a lumen and the character of the discharge. Congenital urinary fistulæ are distinguished by the character of the discharge and by the fact that it is increased at the time of urination.

Treatment.—In the case of granulomata cauterization or curetting followed by a powder of equal parts of starch and zinc oxid will usually suffice. The adenomata should be excised. In the case of either omphalomesenteric or urachal fistulæ the only adequate treatment is excision.

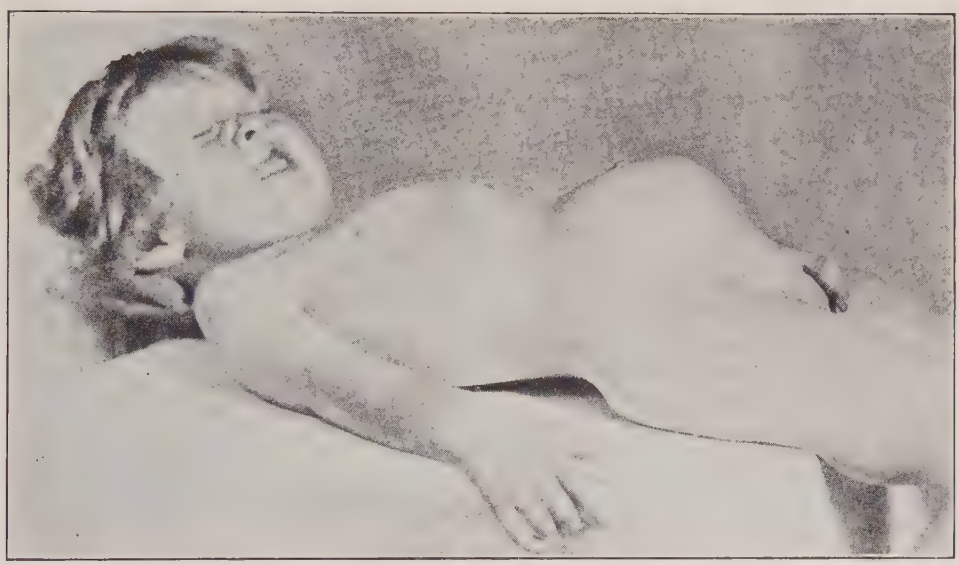

Fig. 166.—Cyst of the Urachus in a Boy Four Years Old.

Operation should, of course, be deferred until the child is in good condition as there is no immediate urgency. In the event of suppuration in a patent urachus with subumbilical phlegmon, incision and drainage are indicated.

*Urachal Cysts.*—If the central portion of the urachus persists, shut off at both the umbilical and vesical ends, a cyst may result.

The treatment is laparotomy and removal.

## CONGENITAL HYPERTROPHIC PYLORIC STENOSIS

The incidence of congenital hypertrophic stenosis of the pylorus is not accurately known but has been estimated as being about once in two hundred births. In spite of a voluminous literature the importance and frequency of the condition remain unappreciated. The clinical picture and

appropriate treatment should be as familiar to the general practitioner as are those of appendicitis.

The etiology of the disease remains obscure. The weight of evidence is in favor of a primary developmental hyperplasia of the circular muscle-fibers involving the pyloric antrum and to a less degree or not at all the pyloric ring. The hyperplasia is probably congenital, has been noted in a seven months' fetus and, in several instances, within a few days or hours of birth. The longitudinal layer of muscle-fibers and the submucous coats are usually quite normal. The walls of the stomach are somewhat thickened and its cavity is commonly dilated. Associated with this hyper-

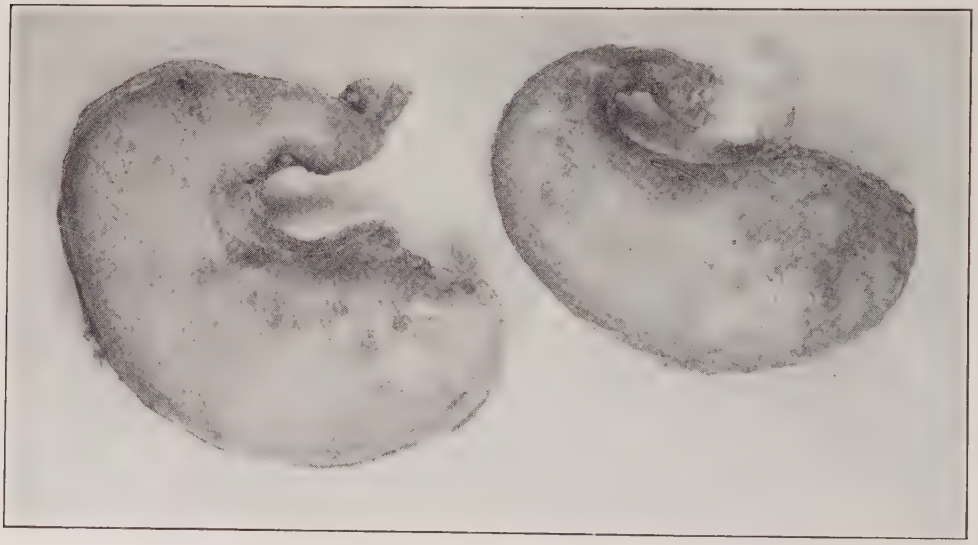

Fig. 167.—Normal Stomach at Eight Weeks Compared with That of a Patient with Congenital Hypertrophic Stenosis of the Pylorus at the Same Age.

plasia is a secondary increased functional activity and the combination results in pyloric obstruction. The hypertrophy alone does not often produce sufficient narrowing to cause symptoms in infants. Not until spasm has been added do the symptoms appear. I am, however, of the opinion that in all cases hypertrophy precedes spasm. It is definitely known that the hypertrophy continues long after the spasm has subsided. As a result of the muscular hyperplasia the pyloric antrum forms a tumor which varies in size from that of the distal phalanx of the little finger to that of the distal phalanx of the thumb, according to the age and development of the infant. The condition occurs usually in breast-fed male children, frequently the first born. It may occur in one of twins, the other being normal.

The clinical picture is striking and quite uniform. A previously healthy baby, usually breast fed, who has shown no signs of disturbance begins to vomit persistently and forcibly. Shortly there is marked constipation, little urine is passed and there is progressive loss of weight.

The onset is frequently abrupt but may be gradual and occasionally dates from birth. In the majority of cases symptoms begin in the second to fourth week. Onset after the fifth week is rare and after the eighth week exceptional.

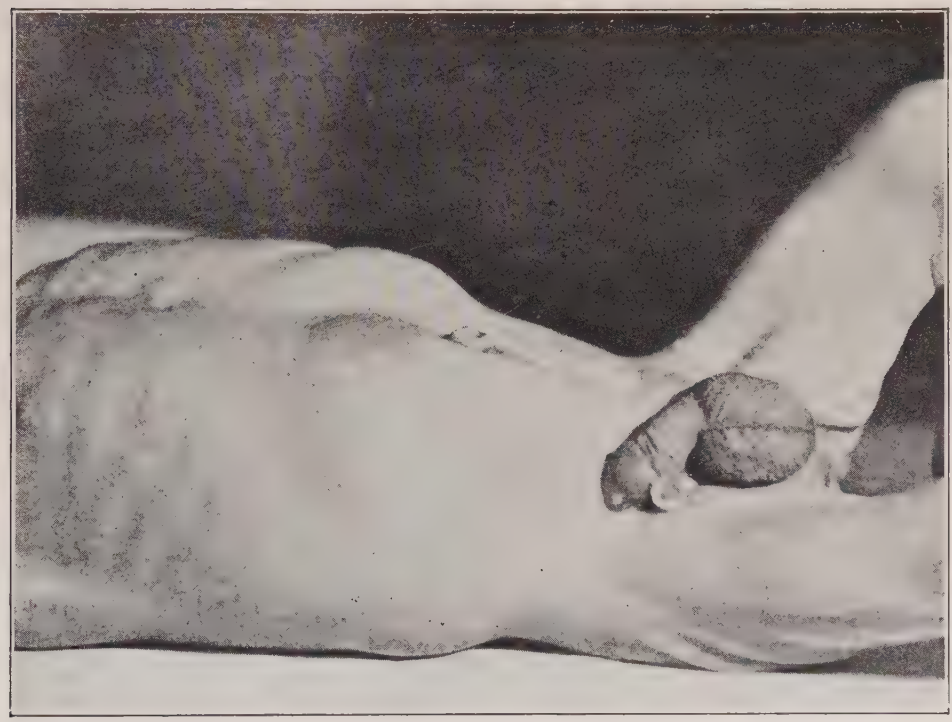

Fig. 168.—Peristaltic Waves, Congenital Hypertrophic Pyloris Stenosis in an Infant Ten Weeks Old.

The vomiting is characteristic. It is forcible and projectile. Sometimes the food is shot out of the mouth to a distance of several feet. This may be repeated after each nursing and the amount of vomitus is large, usually the entire contents of the stomach. If the vomiting is infrequent the amount ejected at one time is often larger than the amount of the last feeding. There is always gastric retention, which may be estimated by means of a soft rubber catheter to which is attached a simple suction apparatus. Definite gastric peristaltic waves may be seen, and the tumor palpated. Throughout the course of the disease there is no fever and the infant usually remains hungry.

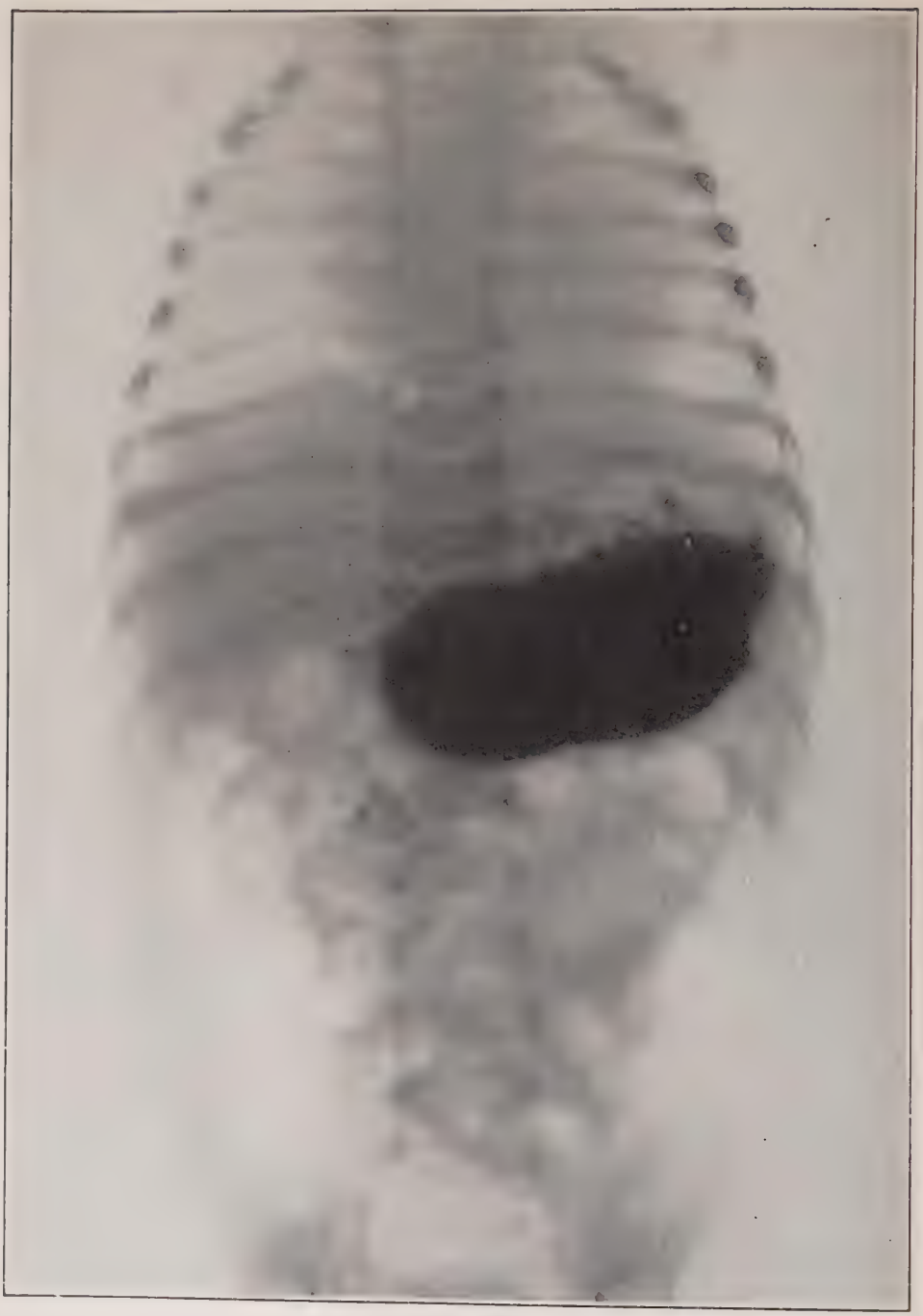

FIG. 169.—CONGENITAL HYPERTROPHIC PYLORIC STENOSIS IN MALE INFANT FIVE WEEKS OLD. Roentgenogram five minutes after opaque meal.

FIG. 170.—SAME PATIENT AS IN FIGURE 169.

Roentgenogram four hours after opaque meal. There is no dilatation of the stomach but considerable retention. Diagnosis was verified at operation. A typical Fredet-Rammstedt operation was done and convalescence was uneventful.

It is asserted that persistent spasm without hypertrophy may give a picture identical in all respects save the presence of the tumor. The truth of this assertion has never been established to my satisfaction. Occasionally, exploratory operation has been undertaken in vomiting babies and no definite pathologic cause for the vomiting found. In such cases, I see no indication for any operation on the pylorus.

The history, if obtained from an intelligent person, is often valuable and may be typical. With the condition in mind the diagnosis can usually be made promptly and is not a matter of opinion but is demonstrable. A palpable pyloric tumor and gastric peristaltic waves in combination occur in no other condition. The value of palpation of the tumor as a diagnostic sign has been variously estimated by different writers. In my opinion it is the most important sign and I am confident that if sought in the proper manner the tumor may be felt in every instance. Occasionally it may be made out at once without any preparation of the patient. This is most frequently true when examination is made immediately after vomiting in those cases in which symptoms have persisted for several weeks with resulting emaciation. Usually, however, the palpation of the tumor is most easily carried out after the stomach has been emptied by means of a soft rubber catheter. The child is kept quiet with its usual feeding or a sugar pacifier. The pylorus may usually be made out to the right of and just above the umbilicus. Less frequently it is found high up under the liver or even in the midline just below the ensiform cartilage. The tumor is a small, oblong, movable mass, about the size of the distal phalanx of the little finger, and imparts a sense of almost cartilaginous hardness through the abdominal wall. Its consistency varies as the muscle comprising it is contracted or relaxed. During relaxation the pylorus is soft and though it may be made out it is in this phase not sufficiently characteristic to be conclusive. When once it has been located the contraction and hardening of the pylorus may be stimulated by gentle kneading with the finger. In this connection it is interesting to consider the appearance and behavior of the tumor at operation. It is a mistake to describe it as being glistening white and of a cartilaginous hardness. This is true of only one phase. Usually, when delivered at operation, the tumor is firmer than the adjacent stomach wall but its color is only slightly, if at all, lighter than the rest of the stomach. At the first stroke of the knife, or during manipulation, the tumor is seen to blanch, to become somewhat constricted in the center and to change its consistency to a cartilaginous hardness. In very thin infants the tumor is obvious. In early cases it is more difficult to make out. Patience and persistence will, however, be rewarded in practically every instance, and a typical pyloric tumor is conclusive.

Fig. 171.—Congenital Hypertrophic Pyloric Stenosis in Male Infant Ten Weeks Old.

Roentgenogram five minutes after opaque meal. Compare with Figure 167. Note enormous dilatation of stomach.

Visible peristaltic waves are a valuable sign. Their significance depends upon their degree. Small waves may be seen in apparently normal infants. If the epigastric region is inspected after the stomach is filled and while the child is quiet, deep, regularly recurring waves passing from left to right may be seen in almost every instance. Similar waves occur in congenital atresia of the duodenum but the presence of symptoms from birth and the bilious character of the vomitus generally serve to distinguish this anomaly.

In my experience a definite diagnosis of pyloric stenosis may be made without the aid of roentgenography. In occasional cases, where the history is suggestive but in which no tumor is palpable, an opaque meal is used to confirm the absence of gastric retention. In those infants who vomit from birth the early use of roentgenography is imperative. In such cases there is strong probability of a congenital anomaly of the duodenum which a roentgenogram will reveal. Certain of these anomalies are amenable to surgical treatment and the more promptly they are diagnosed and operated the more frequently will a cure result.

Projectile vomiting may be observed during the examination. Loss of weight, constipation and scanty urine are evidence of starvation. Quite often in the advanced cases there may be frequent passage from the bowel of green fluid stools without substance.

There are so many discrepancies and differences of opinion in the literature of pyloric stenosis that, having no personal experience with the medical treatment, I do not feel qualified correctly to interpret or discuss its results. Whatever these results may be, there seems to be no doubt that, in a large proportion of cases managed by medical methods, the treatment extends over a period of weeks and months, during the whole of which careful medical supervision and expert nursing are essential. The dangers of protracted hospital care in infants are well known. In addition to its practical difficulties, this prolonged convalescence suggests the likelihood of increased susceptibility to infection and the possibility of permanent damage to the growing infant, from impaired nutrition at a critical stage in its development. If the condition is recognized shortly after the onset of symptoms, medical treatment may, in my opinion, be tried in mild cases and persisted in if the symptoms are relieved within one week. There are certain cases that respond promptly: vomiting ceases and the infant gains steadily. Obviously, there is no indication for surgery in this type. No medical treatment which involves discontinuance of the use of breast milk is permissible. Patients first seen in the later stages should be operated on as soon as possible. Surgeons competent to do the operation are at least as common as physicians competent to treat such a case by medical methods.

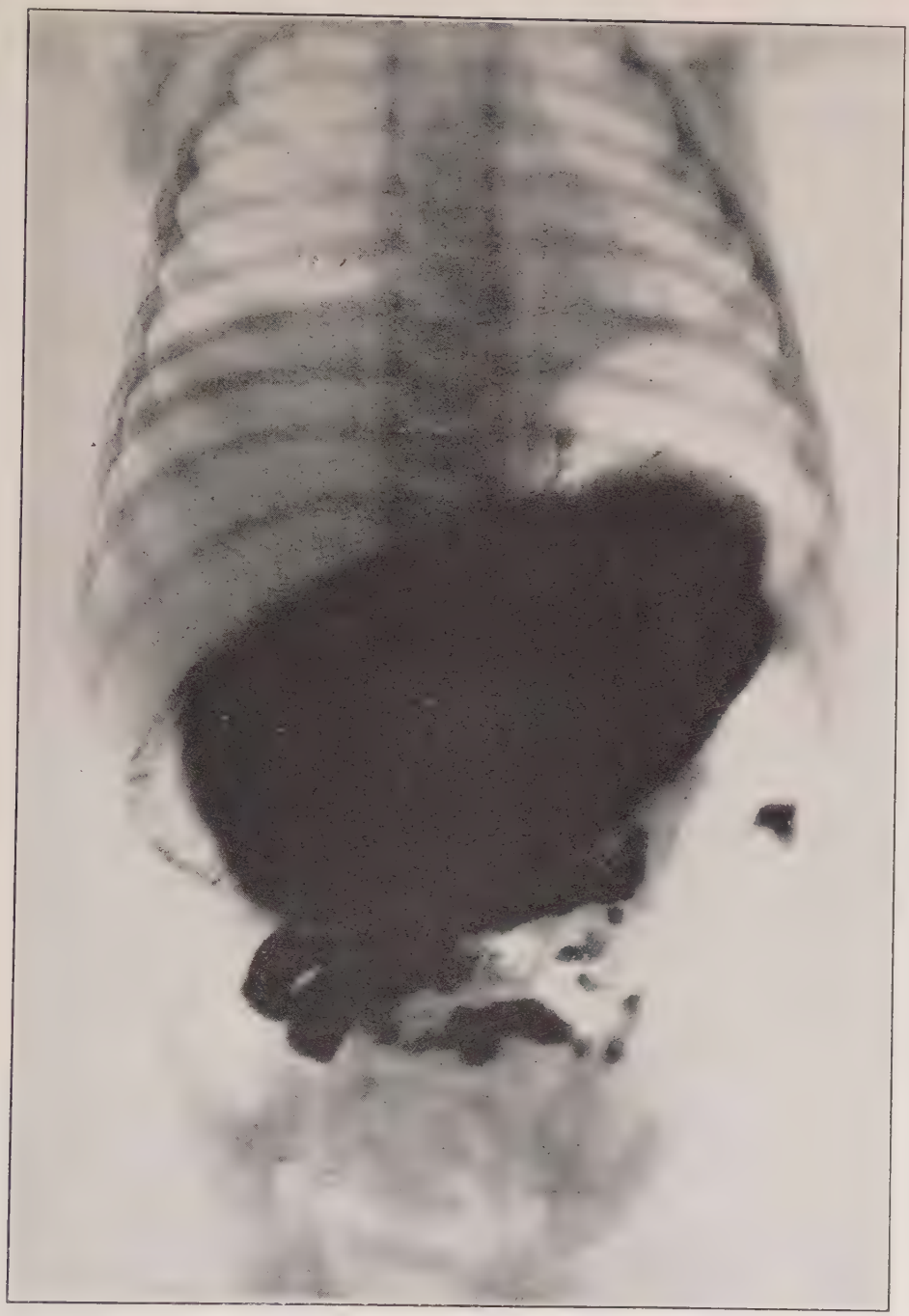

FIG. 172.—SAME PATIENT AS IN FIGURE 171.

Roentgenogram at end of four hours; note retention. Diagnosis confirmed at operation. A typical Fredet-Rammstedt operation done. Convalescence uneventful.

**Preparation for Operation.**—The operation should not be carried out as an emergency measure. Infants in reasonably good condition, who are not dehydrated, may be operated upon within twenty-four hours of admission to the hospital. Even in such patients a hypodermoclysis of 3 per cent glucose in salt solution is usually given about twelve hours before operation.

Where symptoms have existed for a long time and the infant is emaciated and dehydrated, operation should be delayed for two or three days. During this time the body heat is carefully maintained, frequent hypodermoclyses are administered and one or more transfusions given. Direct transfusion into a peripheral vein is the method employed. The improvement thus brought about in apparently moribund infants is often remarkable. In the past when the operation in advanced cases was considered an emergency procedure, deaths from collapse shortly after operation were not infrequent. Since the preliminary measures mentioned have been in use the number of deaths from collapse has been greatly reduced.

**Operation.**—In my experience the Fredet-Rammstedt operation has proved so uniformly satisfactory that I have seen no indication to modify it. Opinions are varied as to the use of local or general anesthesia. For my part, in those infants whose nutrition is good I consider ether, properly administered by the open drop method, as the anesthesia of choice. Where the infant is in poor condition I prefer local anesthesia. When local anesthesia is indicated the child is kept quiet with a sugar pacifier and the line of incision is infiltrated with 1 per cent procain. It is essential that the posterior rectus sheath and peritoneum be widely infiltrated. In nine out of ten cases the operation may be completed under local anesthesia alone. In the tenth case it will be necessary to give a little ether to close the incision. An incision 1½ inches in length is made through the middle of the right rectus muscle and, if possible, placed so as to overlie the right lobe of the liver. Just before the peritoneum is opened the stomach is emptied by means of a catheter. The stomach is picked up with plain forceps and the pyloric tumor delivered through the wound. With the tumor held between the thumb and forefinger of the left hand an incision involving only the peritoneum and the superficial muscle-fibers is made. This incision begins just proximal to the duodenum, is parallel with the lumen of the pylorus and the pyloric antrum, extends well on to the wall of the stomach and varies in length from ¾ to 1 inch. It should be made through the most bloodless part of the pylorus, which is on the anterior surface and usually at the junction of the upper and middle thirds. A pair of straight mosquito forceps is inserted in the center of the incision and gently spread. The undivided portion of the muscle tears, thus exposing the mucous membrane. The blunt dissection is continued toward

the duodenum and carried in the line of cleavage to the duodenal ring. The separation of the lips of the incision in the muscular layer should be sufficient to permit the mucous layer to protrude freely into the wound beyond the level of the peritoneal covering.

The transition from the thick-walled pyloric antrum to the thin-walled duodenum is abrupt and great care is necessary to avoid tearing the mucous membrane. As the hypertrophied muscle of the tumor gradually merges into the relatively normal muscular layers of the stomach there is little danger of entering the lumen on the stomach side. Pressure with hot pads usually controls bleeding. Bleeding vessels in the cut edges of the incision in the pylorus may be underrun with fine silk ligatures. A small vessel toward the duodenal end of the incision and beneath the muscle layer may be ruptured. Bleeding from this source is best controlled by pressure with a small piece of muscle cut from the rectus and, if necessary, fixed in place with a suture. No attempt is made to cover the wound with omentum.

The abdominal wound is closed in layers with meticulous care. The dressing, which is small, is securely fixed with adhesive straps which are long enough to extend on to the back.

**Accidents and Complications.**—Although the danger of opening into the lumen of the duodenum has been exaggerated the possibility does exist even in experienced hands. If perforation occurs the rent in the mucosa may easily be repaired by a ligature or suture of fine silk. Failure to recognize the accident is disastrous and usually results in peritonitis.

Hemorrhage from the pyloric wound may occur in rare instances and careful hemostasis is essential. The use of a continuous suture in each layer of the abdominal wall, together with accurate apposition of the skin edges reduces the danger of bleeding from the abdominal wound to a minimum.

Material infection of the wound is rare. Not infrequently there is some irritation at the suture exit which clears up immediately after the sutures are removed. Where there is purulent discharge from the umbilicus at the time of operation infection of the wound usually occurs in spite of every precaution.

Separation of the wound edges has occurred in several instances and in two cases resuture of the wound was necessary. Ventral hernia is an unusual complication and may usually be cured by strapping with adhesive plaster.

**Postoperative Management.**—The postoperative care in breast-fed babies is relatively simple. Too much stress cannot be laid upon the importance of an adequate supply of breast milk for at least the first ten days after operation in all cases. After general anesthesia the head of the

crib is lowered for an hour or two to prevent the aspiration of mucus. The body heat is carefully maintained. Hypodermoclysis of glucose solution is given as indicated. Transfusion of blood is often of value.

The tolerance for food in those infants who have been starved over long periods is often markedly reduced and great care is necessary in in-

FIG. 173.—RESULT SIX YEARS AFTER FREDET-RAMMSTEDT OPERATION IN AN INFANT FIVE WEEKS OLD.

Roentgenogram six minutes after opaque meal. The stomach was completely empty at the end of six hours.

creasing their diet. One or two hours after operation ½ ounce of water is given, followed in one hour by 1 dram of breast milk with 1 dram of barley water. The breast milk is repeated every three hours, eight feedings a day, and is alternated with the water. Both are gradually increased and at the end of forty-eight hours the child is usually taking one ounce. Thereafter the feedings are increased one or two drams daily until the caloric requirements of the child are met. When a supply of breast milk cannot

be obtained a suitable formula is substituted. During the first few days after operation the administration of water by mouth is of great importance.

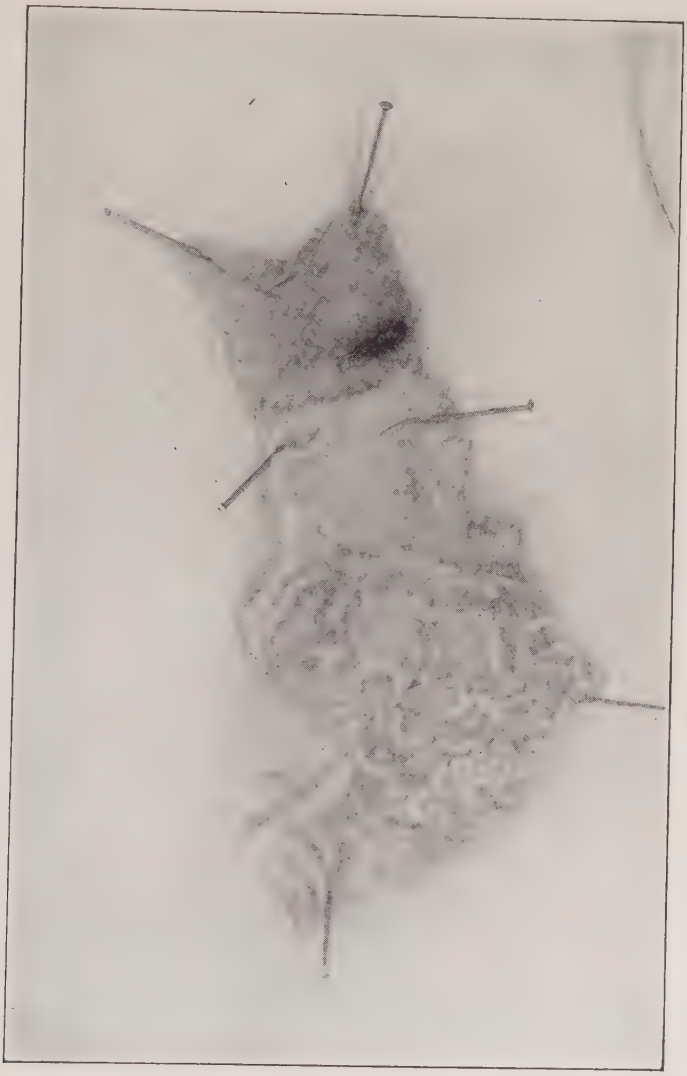

Fig. 174.—Duodenal Ulcer, Specimen Removed at Autopsy on Baby Four Months Old.

For the first four or five days feedings are by means of a medicine dropper. A soft rubber catheter may be passed into the stomach as often as is necessary before feedings to provide for the free escape of gas. Every effort should be made to preserve the mother's supply of milk. The baby should nurse on the sixth or seventh day, in some instances sooner. The nursings are increased daily and are carefully supervised.

If the quantities obtained are too small the nursing should be supplemented. If it is necessary to discharge the child on a formula this should be gradually substituted for the breast milk, beginning on the tenth or twelfth day after operation. The average stay in the hospital of breast-fed babies is thirteen days; of those artificially fed, eighteen days is the average stay.

**Results.**—Following the Fredet-Rammstedt operation the pylorus is anatomically and functionally normal. Martha Wollstein, the pathologist at the Babies' Hospital, in a study of twenty-three specimens removed in from twenty-four hours to two years after operation, has shown that the condition is cured by the operation. In twenty-five days after operation the stomach is normal in size, and the pylorus but slightly thicker than normal. In six weeks only a delicate scar remains. In only one instance in my experience has the operation proved inadequate. Many patients have now been followed for varying periods up to twelve years and in no instance has there been evidence of pyloric obstruction or of any symptom referable to the operation.

There has been a gradual reduction in the operative mortality which is to be attributed not only to an increase in the proportion of favorable cases but also to certain changes in the care of patients before and after operation. In the past two years I have operated on sixty-six cases with a mortality of less than 5 per cent. The duration of symptoms prior to operation is probably the most important single factor affecting prognosis. The mortality in artificially fed babies is three times that in the breast fed. All deaths in the hospital following operation are classed as operative deaths. The so-called operative mortality is largely that of delay in diagnosis or in the choice of surgical treatment.

## ABDOMINAL CONTUSIONS

Contusions of the abdominal wall result from various forms of violence. The clinical features are those common to bruises elsewhere, with, in addition, a variable degree of shock. The importance of such injuries depends almost entirely on the possibility of damage to the contained viscera. Contusions or wounds of the viscera most often result from severe violence as by a kick, the passage of a wheel across the body or any crushing injury or fall. A common source of abdominal injury in children during the winter months is a fall from a sled or toboggan.

Any severe contusion of the abdomen, even without visceral injury, results in shock and for a varying period after the accident there may be no definite features which serve to differentiate the simple contusions from those with associated visceral damage.

**Clinical Features.**—The clinical features of visceral injuries vary with the severity of the violence, the extent of the damage and the viscus involved. Often there is no visible evidence of abdominal wall injury. The degree of shock varies widely. There is persistent pain, vomiting is usually present and there is rigidity of the abdominal muscles. The belly is, at first, scaphoid, subsequently becoming distended. The rupture of a solid viscus is attended with hemorrhage and if severe the initial shock merges into the symptoms of acute anemia, pallor increases, the pulse becomes small and frequent, the patient is restless and evidences air-hunger. There may be no immediate qualitative change in the blood though this will shortly be manifested in severe hemorrhage. In rupture of a hollow viscus the symptoms, depending on the amount of leakage, merge gradually or rapidly into those of peritonitis.

**Diagnosis.**—Diagnosis is often difficult. A history of the nature and degree of violence is important. While persistent shock suggests visceral injury it is not necessarily present in all such injuries. Widespread soreness and rigidity extending beyond the area of contusion are most suggestive. The most reliable signs of rupture of a hollow viscus are rigidity of the abdominal muscles and persistent vomiting. The signs of hemorrhage have been enumerated. Rupture of the urinary bladder may easily be overlooked and in severe abdominal injuries catheterization is indicated, particularly when there is collateral evidence of fracture of the pelvis. If a roentgenogram can be made without delaying any other indicated procedure it occasionally proves of value in demonstrating a spontaneous pneumoperitoneum.

**Treatment.**—When it is impossible to arrive at once at a definite conclusion the patient is kept under observation; a written record is made of the rate and quality of the pulse at half hourly intervals. The condition of the abdominal muscles is frequently noted and repeated blood-counts made. When the diagnosis remains doubtful an exploratory operation is probably the wisest course unless the patient is in a state of severe shock. Delay in operating on a patient with a ruptured hollow viscus may result fatally, while an exploratory operation carries little risk. The initial shock is treated by appropriate measures. The patient is grouped for transfusion and a donor secured so that if transfusion becomes necessary there will be no delay. The judicious use of morphin is of value. If operation becomes necessary the abdomen is opened over the site of the injury or in the midline. If hemorrhage is found it is traced to its source; if from the liver the wound is packed, if from the spleen the organ is removed and if from the kidney the wound is either sutured or packed or the organ removed, depending on the extent of the damage. Where injury to the kidney is diagnosed without other complicating injuries it has been

shown that conservative measures, without operation, usually suffice. Systematic examination of the intestine from end to end beginning at a fixed point, usually the ileocecal valve, forms a part of every operation for abdominal injury.

## PERITONITIS IN THE NEWLY BORN

Peritonitis as one of the pathological processes in pyemic infection of the newly born (neonatal sepsis) is not infrequent. It is very often the cause of death and in a considerable proportion of cases it is the most important lesion found. Infection may occur before birth, at birth or in the first few weeks of life. Most frequently the portal of infection is the umbilicus. Less often through a wound or abrasion of skin or of any mucous membrane or mucocutaneous surface. While the milk of a mother suffering from septicemia or suppurative mastitis contains organisms, it is unlikely that the infant will be infected by taking such milk. There may be no external evidence of disease and the portal of infection may be in doubt. The organisms concerned are most frequently streptococci and staphylococci. Very infrequently pneumococci and gonococci are found.

**Clinical Features.**—The process is usually generalized, resembling septic peritonitis in adults. It may, however, be localized, often in the neighborhood of the umbilicus or liver. While the symptoms may be all those expected in any generalized peritonitis—persistent vomiting, progressive abdominal rigidity and distention, pouting of the umbilicus, flexion of the thighs, etc.—there are not infrequently instances where the onset is insidious and there is little to draw the attention to the abdomen aside from a gradually increasing abdominal distention. As a matter of fact diagnosis is often presumptive and rests more on probability than on physical signs. In the very young infants abdominal distention, dilatation of the abdominal veins and a certain congestion of the skin of the abdomen associated with vomiting are the most important signs.

Strict cleanliness at the time of delivery and thereafter in the handling and care of the child is a most important prophylactic measure.

**Treatment.**—Where there is a local collection of pus, incision is indicated. In generalized peritonitis operation offers nothing and is not indicated. Whatever chance there is rests in localization of the process and the formation of an abscess. Treatment should consist in general measures directed to the maintenance of nutrition with particular attention to the administration of fluids by hypodermoclysis and to repeated transfusion.

**Prognosis.**—When the peritonitis is localized and an abscess results recovery occasionally follows drainage or even spontaneous evacuation.

In generalized peritonitis at this time of life recovery is practically unknown.

## PERITONITIS IN INFANTS AND YOUNG CHILDREN

Peritonitis from pneumococcus or streptococcus infection is the most formidable abdominal catastrophe met with in infancy and early childhood. The condition is classed as primary when the peritoneal infection is the original manifestation of the disease. In the secondary type the infection has extended to the peritoneum from an extraperitoneal site either by way of the blood stream or by direct extension.

**Pathogenesis and Etiology.**—There is so frequently a history of some upper respiratory or pharyngeal infection that one can scarcely escape the conviction that there is a direct relationship between the infection in the throat and the peritonitis. This is particularly true in the infection by streptococcus.

Infection of the peritoneum may occur through one of several portals of entry:

1. By the blood stream. It has been claimed by some that peritonitis is always secondary to a bacteremia. Undoubtedly when the peritonitis is secondary to a pneumonia the organisms reach the peritoneum by the blood stream.

2. By the genital tract. Pneumococcus peritonitis unless secondary almost invariably occurs in girls, usually of the poorer classes and at an age, three to seven years, when infection through the vagina is most likely.

3. By the gastro-intestinal tract.

Infection may occur in each of these ways. I am convinced, however, that pneumococcus peritonitis is usually a direct infection through the genital tract, while the streptococcus infection appears to be usually hematogenous in origin.

**Clinical Features.**—The onset is abrupt with high fever reaching 104° to 106°. Vomiting appears early and is persistent. Diarrhea is frequent in the early stages of the disease. The abdomen is rigid and tender. This is at first most marked in the lower abdomen as the condition almost always starts as a pelvic peritonitis. The severity of the attack varies greatly and while in some instances there is almost immediate evidence of profound toxemia, death supervening within thirty-six hours, in others the child may not at first look very ill. Leukocytosis is usually above 20,000 with a polynucleosis above 90 per cent. In short, the picture is that of a severe general infection with local manifestations in the abdomen. The condition

may become progressively worse until death occurs or the symptoms may gradually become less and finally a fluctuant swelling appears in the subumbilical region which proves to be an abscess. The onset may be less severe and the child may have been out of bed for several days before the swelling in the abdomen is noticed. This subacute or chronic form is

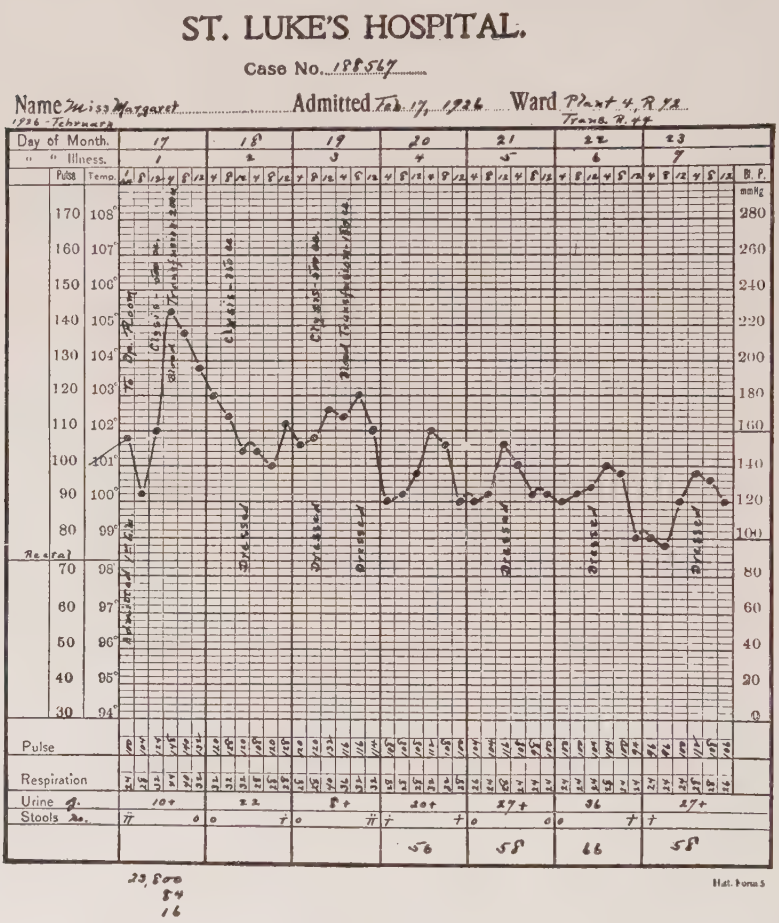


FIG. 175.—TEMPERATURE CHART OF FIRST POSTOPERATIVE WEEK IN A CASE OF PRIMARY STREPTOCOCCUS PERITONITIS IN A GIRL SIX YEARS OLD, ILLUSTRATING THE VALUE OF TRANSFUSION OF BLOOD. THIS CHILD SURVIVED.

very rare in the case of a streptococcus infection but is more common where the pneumococcus is the infecting agent.

**Pathology.**—In the early stages the condition is usually limited to the pelvic peritoneum. This is as true in streptococcus peritonitis which is most frequently seen in boys and is probably hematogenous in origin, as it is in pneumococcus peritonitis which is almost invariably seen in girls and is probably a direct extension from the genital tract. In the early

stage the exudate is glairy, clear and rather sticky. In the later stages it becomes frankly purulent. The peritoneal surface is deeply injected and the mesenteric lymph-nodes are enlarged throughout. Blood-cultures are frequently positive.

**Diagnosis.**—If the condition is borne in mind the diagnosis may often be made. The very high temperature and leukocytosis suggest a respiratory infection but the abdominal symptoms are marked and in the lower abdomen. The rapid rise of temperature within the first few hours is unusual in appendicitis. The question is often between pneumonia and peritonitis. The diagnosis may be confirmed by a peritoneal puncture by means of a fine needle, about gauge 16 with a short bevel. The puncture is usually made in the midline one inch below the umbilicus. There is little danger of wounding the intestine. If a drop of fluid does not appear suction with a syringe will usually suffice to produce enough for a smear and culture. Where there remains doubt as to the condition of the chest use of the Roentgen ray is indicated. Differentiation between peritonitis from streptococcus and pneumococcus infection is impossible without peritoneal puncture.

**Treatment.**—Operation is usually indicated when the patient is seen early in the disease, not with the idea that much may be accomplished but in order to avoid the possibility of error in diagnosis and the overlooking of a ruptured appendix. When a localized abscess is found drainage is indicated. When there is general infection of the peritoneal cavity without any local evidence of necrosis I see no indication for drainage. In such cases it is my practice to close the peritoneum and to drain the subcutaneous tissue by means of rubber dam. Every effort is made to avoid trauma to the peritoneal surfaces. The general treatment is of the greatest importance. Fluid in ample amounts should be given by hypodermoclysis, usually in the form of 3 per cent glucose in salt solution. Repeated direct transfusion is indicated and the result is sometimes dramatic. There has been some discussion as to the choice of time for transfusion. The best time is immediately after the diagnosis of peritonitis has been made and the transfusion should be repeated as indicated. In a child of six years 200 to 250 c.c. of blood should be given. Sufficient codein or even morphin is given to insure quiet. Persistent vomiting is treated by gastric lavage. In those patients seen late when the child is in extremis and the diagnosis has been confirmed by means of peritoneal puncture there is little if any indication for drainage of the peritoneal cavity. Occasionally the distention may be so great that an ileostomy is indicated. When the process is localized and an abscess has developed the indication for drainage is obvious.

**Prognosis.**—The younger the child the worse is the prognosis. The outlook is bad in any event. What chance there is consists in maintaining,

and if possible increasing, the patient's resistance so that he may localize the infection. Transfusion of blood is our most valuable measure. In acute cases the prognosis is poor; in the subacute or chronic cases recovery is relatively frequent.

## ABDOMINAL TUBERCULOSIS

The alimentary canal is one of the most frequent sites of entrance of the tubercle bacillus into the body and it is in the region of the lower ileum and cecum that this entrance usually occurs. The organisms may pass through the intestinal wall and leave no pathological change. Tuberculous ulceration of the intestine is uncommon in the young save when associated with advanced pulmonary lesions.

### Tuberculosis of the Retroperitoneal and Mesenteric Lymph-Nodes

The infection is almost always through the intestinal tract. Comparatively few children escape without some infection of the retroperitoneal lymph-nodes but usually the lesion is circumscribed. In some cases, however, the process extends, often when the glands at the ileocecal angle and in the mesentery of the small intestine are involved.

**Clinical Features.**—The symptoms are those of a general disturbance of nutrition. It is seldom that there are symptoms pointing directly to disease of the digestive tract. However, the affected glands are prone to recurring attacks of lymphadenitis and inasmuch as they are frequently situated in the region of the cecum, differentiation from appendicitis may be very difficult if not impossible. Rarely the glands become sufficiently enlarged to cause partial intestinal obstruction. Occasionally they break down and form a retroperitoneal or mesenteric abscess. When the abdominal wall is relaxed enlarged glands may often be felt. They are usually regular in outline, elastic in consistence, slightly movable if in the mesentery and tender if palpated during one of the frequently recurring attacks of inflammation.

**Diagnosis.**—Disturbance of nutrition, slight elevation of temperature, palpable glands in the abdomen and a positive tuberculin test make the diagnosis justifiable. The diagnosis of a tuberculous abscess in the mesentery is impossible without an operation. Examination of the spine usually serves to differentiate a psoas abscess from an abscess of the retroperitoneal glands. As has been mentioned, the differentiation from appendicitis may be impossible. In such cases it is wise to do an exploratory operation.

**Treatment.**—The condition of itself rarely calls for surgical interference. When met with in the course of other operations it is extremely important to recognize it and avoid contamination of the general peritoneal cavity. A small gland, easily accessible, may be removed. No attempt to remove large masses should be undertaken and the rupture and incision of a gland should be carefully avoided. Occasionally a mass of glands at the ileocecal angle causes intestinal obstruction, in which case a short-circuiting operation is indicated.

### Tuberculosis of the Peritoneum

This condition may be met with at any period of life but is most commonly seen in children and young adults. It is rare in infancy. Except as a manifestation of general miliary tuberculosis the condition is secondary, as a rule, to some other tuberculous lesion in the abdomen. In children the focus is most frequently in the mesenteric or retroperitoneal lymph-nodes, more rarely in the fallopian tubes. The process may be acute but is usually chronic.

**Acute.**—The peritoneum is studded with tubercles and there is a plastic exudate agglutinating the adjacent coils of intestine. The process may be so severe as to simulate pyogenic peritonitis and is not amenable to surgical treatment.

**Chronic.**—This form may be divided into two types according as the effusion of fluid or the formation of adhesions is the dominant feature.

1. *Tuberculous Ascites.*—This type is said to be less common than the adhesive form. In my personal experience the contrary has been true. The peritoneum is more or less thickly sown with tubercles. There is a small amount of fibrin and a large serous exudation. The fluid may be diffused through the whole peritoneal cavity or may be sacculated in one or more areas by adhesions. The fluid is usually straw colored but may be seropurulent or even bloody.

Clinical Features.—In these cases there is a gradual loss of flesh and strength and often the symptoms of a low grade of peritoneal inflammation. There may or may not be a slight rise in temperature. The peritoneal cavity slowly fills with fluid and there may be nothing distinctive until abdominal distention is noted. At times enlarged mesenteric glands can be palpated or the rolled-up omentum can be felt in the upper abdomen. In some cases abdominal enlargement is practically the only symptom. In boys the first manifestation may be the gradual development of a hydrocele which is reducible under pressure and subject to variations in size. At operation the sac will be found to be studded with tubercles. Death may occur from slow exhaustion from the local condition or as a

result of generalized tuberculosis. In other cases the fluid may undergo absorption and recovery take place.

2. *Adhesive Form.*—This is usually slower in development. The most important feature is the production of a large amount of fibrous tissue together with extensive caseous deposits. There is often an associated ascites. Adhesions between the intestinal coils and between the intestines and the abdominal wall may result in intestinal obstruction. There may be involvement of the intestinal walls with perforation and the formation of fistulæ.

Clinical Features.—Irregular masses may be made out, frequently in the epigastric region. Chronic intussusception, characterized as it is by wasting and a mass, may be difficult to differentiate. The course is very chronic and the only characteristic symptom may be enlargement of the abdomen. Intestinal obstruction may develop. The condition may be entirely latent and be only discovered at autopsy. Diarrhea may be a prominent feature. When there is breaking down of the inflammatory products the abdominal wall may be involved in the neighborhood of the umbilicus and an abscess may point in that region. The condition may be mistaken for the more chronic form of pneumococcus peritonitis.

Diagnosis.—Enlargement of the abdomen, the presence of free or encysted fluid, diarrhea, irregular abdominal masses, slight fever and a positive tuberculin reaction are the essential features. Ascites in young children usually means tuberculous peritonitis. A pouting umbilicus or an abscess pointing in this region is suggestive. Pneumococcus peritonitis and chronic intussusception may cause confusion.

Treatment.—Under favorable conditions with the usual general measures for tuberculosis there is, particularly in the ascitic form, a decided tendency to recovery. In addition there should be prolonged rest in bed combined with heliotherapy. When progress is not favorable under medical treatment laparotomy is indicated in the ascitic form. A short incision is made through the right rectus muscle opposite the umbilicus, the fluid is evacuated and the wound very carefully sutured in layers, without drainage.

Infection of the wound is disastrous and usually results in a permanent sinus. Some surgeons have advised distending the peritoneal cavity with oxygen just before the last suture is tied. Paracentesis is contra-indicated on account of the danger of wounding an adjacent loop of bowel. When there is pointing of an abscess an incision should be made in spite of the fact that a permanent sinus will probably result. In the adhesive form operation may be indicated for diagnosis or to relieve an intestinal obstruction.

### Tuberculosis of the Intestines

Surgical treatment is rarely indicated in tuberculosis of the intestines in children. The presence of tuberculous lesions in the intestines, usually in the lower ileum and occasionally in the cecum, is common. The lesions of the intestines are usually of minor importance as they are commonly associated with an advanced pulmonary condition. Primary intestinal lesions do occur, probably from the ingestion of infected milk. Where there is evidence of intestinal obstruction a short-circuiting operation or even excision of the affected area may be indicated.

## APPENDICITIS

**Acute Appendicitis.**—After the first two years of life appendicitis is the most frequent of all the acute emergencies of abdominal disease. While primarily a disease of young persons no time of life from earliest infancy to old age is exempt. Approximately 50 per cent of the cases appear in the period from the second to the twentieth year. The condition is exceptional in the first year and rare in the second. After this period it becomes progressively more common up to the ninth or tenth year. Appendicitis in children over five years of age differs little if at all in pathology and clinical course from the same condition in adults. The diagnosis is, if anything, easier and the results are at least as good. In the younger children, those five years old and under, diagnosis is much more difficult and the mortality is very high, in my experience 20 per cent or just eight times what it is in older children. The usual explanation of this condition of affairs is that the onset is more insidious, the course of the disease more rapid, that the appendix has a greater tendency to rupture and that the child has less resistance. In analyzing a recent series of my own cases I found that only two patients reached the hospital within two days of the onset of symptoms and that the average duration of symptoms was four and a half days. I am convinced that many cases go unrecognized in early life and I believe that the clinical picture of acute appendicitis in young children is founded on a group of cases representing the late stages of the worst forms of appendicular inflammation. It is unreasonable to assume that inflammation of the appendix in young children almost invariably tends to perforation. The impression has been derived from the fact that only the worst cases are recognized and that those cases in which resolution takes place with more or less permanent damage to the appendix, are not usually diagnosed until a subsequent attack at a time of life when the diagnosis is more easily made. The high mortality of appendicitis in young children is due chiefly to our inability to recognize the disease in

its early stages and only to a small extent to whatever difference in clinical course and lack of bodily resistance is peculiar to this period of life. The diagnosis is difficult because a disease essentially similar in pathologic process and clinical course to the same disease in older children and adults occurs in a little child who cannot describe his symptoms and on whom a satisfactory abdominal examination is difficult.

*Anatomy.*—In childhood the appendix is relatively larger than in later life and its junction with the cecum is more apt to be funnel shaped. The amount of lymphoid tissue in the wall during the first two years is small but rapidly increases in amount after that time. The omentum is very poorly developed in young children, notably those under two years and there is little tendency to protective adhesions from this structure. Abnormal positions of the appendix are more common in children, due largely to incomplete rotation of the intestine or to a very mobile cecum.

*Etiology.*—The etiology is in doubt. Sex has little if any influence. Not infrequently the condition is associated with infectious diseases, measles, enterocolitis, etc. The association with tonsillitis has been stressed by many authors.

*Pathology.*—The disease begins as a mural infection and may be blood borne. The bacteria chiefly concerned are the colon bacilli and the pyogenic organisms chiefly streptococci. When there is an association of streptococci with the colon bacilli a particularly dangerous type of peritoneal infection may ensue. Next in importance to infection is obstruction of the lumen. In my experience the presence of a fecalith has frequently appeared to be the determining cause of necrosis and perforation of the wall of the appendix.

*Clinical Features.*—The classical symptoms and signs are pain, usually referred to the umbilical region or epigastrium, later to the region of the appendix, nausea and vomiting, abdominal sensitiveness with muscular rigidity most marked in the region of the appendix. There is moderate elevation of temperature and leukocytosis. The difficulty of diagnosis is inversely proportional to the age of the child. If the disease is confined to the appendix or even limited to a well-localized abscess the appearance and behavior of the child is often such as not to suggest serious illness. The picture of a very ill child, lying motionless on his back with face pinched and pale, thighs flexed, abdomen held rigidly everywhere, thoracic respiration, rapid pulse, is the picture of peritonitis, usually in children the result of appendicitis it is true, but a result which has followed a period, often of several days' duration, of less marked symptoms and signs indicating involvement of the appendix.

Pain, vomiting and fever are particularly difficult to interpret in children. Only rarely in young children is the pain localized and the state-

ment that the child appeared to have "cramps" is the usual history. If the pain is localized it may be either in the umbilical region or in the right lower quadrant. The right thigh is sometimes held flexed and occasionally attention is drawn to the condition by the child leaning to the right when walking. The degree of pain varies within wide limits and may even come in attacks between which the patient is comfortable. However, in fully 90 per cent of the cases the onset is characterized by definite abdominal pain.

Vomiting is occasionally the first symptom noticed and almost invariably occurs at some period of the disease. Constipation is more frequent than diarrhea (the presence of diarrhea does not militate against the diagnosis of appendicitis) but more frequently than either the bowel movements are more or less normal. There is always elevation of temperature at some stage though it may not be elevated at the time of examination. The temperature varies within wide limits but is usually between 100° or 102.5°. Leukocytosis is moderate, usually being about 12,000 or 14,000 with a polynucleosis of 80 to 85 per cent. However, it may be very high or less than normal and no estimate of the bodily resistance of the patient can be derived from the leukocyte count. The temperature and leukocyte count appear unrelated. When the temperature is high the respiratory rate is correspondingly increased. Notably fast respiration is suggestive of lung involvement. With care localized tenderness may be detected. A mass may be palpated and occasionally the mass is not tender. Rigidity is particularly hard to evaluate. Local tenderness is the most valuable of all signs. If corroborated by pain and vomiting with moderate elevation of temperature and leukocyte count the diagnosis is reasonably sure. The absence of no one sign or symptom is sufficient to rule out appendicitis.

Signs and symptoms are modified by the position of the appendix. A retrocecal position adds difficulty to the detection of tenderness which may be referred to the loin. If the appendix extends across the midline or into the pelvis the parietal peritoneum may be protected by the coils of small intestine surrounding the appendix and both rigidity and tenderness are less marked and more difficult to detect. Diarrhea and painful micturition are common in inflammation of the pelvic appendix. Rectal examination, which is of particular value in this situation, should never be neglected. Imperfect descent of the cecum with the appendix lying beneath the liver or malrotation with the appendix in the left iliac fossa transfer the evidence of the disease to these situations.

*Differential Diagnosis.*—A complete careful physical examination is essential in every instance. Of the many conditions outside the abdominal cavity which must be taken into consideration, the onset of a respiratory infection or one of the other infectious diseases is frequently the

most difficult to distinguish. There is often a characteristic appearance in pneumonia, even in the absence of physical signs. A roentgenogram may be of real value in doubtful cases. Attention has been called to the occurrence of severe abdominal pain accompanying throat infections and at the onset of measles. Acute hip disease, osteomyelitis of the femur or ilium, psoas abscess, spondylitis, retroperitoneal abscess in the iliac fossa, inguinal or femoral adenitis, torsion of the testicle and orchitis may all, at times, cause confusion.

Of the intra-abdominal conditions, gastro-enteritis and gastro-intestinal colic are to be differentiated by the history of dietary indiscretion, the usual subsidence of vomiting after the stomach has been emptied and the absence of fever, leukocytosis and localized tenderness. However, many such attacks are probably instances of mild appendicitis. General peritonitis due to the pneumococcus or streptococcus is, at times, impossible to differentiate. Mesenteric lymphadenitis, tuberculous or not, may give a picture that is identical with that of appendicitis. Intussusception is most frequent in the first year when appendicitis is rare and the characteristic history and abdominal tumor will serve to distinguish it. In pyelitis, the temperature, which is irregular, is frequently higher than the physical signs and appearance of the child would indicate. Rigidity is absent and tenderness, if present, is over the pelvis of the kidney. Painful micturition and pyuria may occur in appendicitis, nor does a single specimen of urine without pus exclude pyelitis. Distention of the bladder is not infrequent in children and may cause confusion. In girls a twisted ovarian cyst may be mistaken for the condition.

*Clinical Course.*—From a beginning with the usual acute symptoms the condition may terminate in one of three ways: (1) It may subside more or less gradually until all symptoms and signs have disappeared and there is an apparent complete resolution of the inflammatory process. (2) With subsidence of the more acute symptoms a local inflammatory process remains which usually eventuates in the formation of an abscess. (3) There may be a progression of the disease without localization. All features, general and abdominal, become worse until the picture is that of diffuse peritonitis. In my opinion it is impossible to foretell in the beginning what the probable outcome will be. Therefore to attempt to select those cases which should be operated on and those where the process will undergo spontaneous resolution is a responsibility which it is inadvisable to assume.

*Treatment.*—Acute appendicitis in children is without exception a surgical disease. When a diagnosis has been made operation should be carried out forthwith. There are certain instances in which the suspicion is strong but a definite diagnosis cannot be made. In such cases an exploratory operation is indicated. The risk of a well-conducted exploratory opera-

tion is in no way comparable to the risk of a ruptured appendix. Every child with abdominal pain and vomiting should be considered a potential case of appendicitis. It is in improvement in management of these cases that there is an opportunity to lessen the mortality. It is a matter of common knowledge that one rarely sees a patient with a ruptured appendix who has not had one or more doses of castor oil or other cathartic. By the administration of cathartics a tumult of activity in the intestinal tract is excited, secretion is more profuse and the bacterial virulence is augmented. No child who has an abdominal pain should have a cathartic until the possibility of appendicitis has been excluded. Starvation and enemata will answer all requirements until the diagnosis has been made. If some local application is desired dry heat is preferred to the ice-cap which masks the symptoms.

The method of operation, while of far less importance than an early diagnosis, has some bearing on the outcome. Gentleness is essential and should not be sacrificed to speed. Where drainage is necessary dental rubber dam and occasionally split soft rubber tubes answer all purposes. I practically never use gauze for drainage. It is not desirable to remove and replace the drain. The drain should be loosened and shortened a little every day. If the drain is by chance pulled out very early do not attempt to introduce another drain but a catheter may be introduced and if it enters the tract easily may be left in place.

In abscesses of several days' duration in which the appendix is not readily accessible, no attempt is made to remove it. Where this has been the operative procedure and the wound heals within a reasonable period of time, it is not my practice to advise a second operation for removal of the appendix unless there are definite indications. In a considerable proportion of cases the appendix has been destroyed.

I am convinced that the best incision in smaller children is through the right rectus. This is true also in any case where the appendix extends into the pelvis. The intermuscular incision is used in older children when I feel reasonably certain that the appendix will be easily accessible and in all cases where simple drainage of an abscess is intended when the situation is such as to make drainage possible by this route.

*Postoperative Treatment.*—In all but the simplest cases a hypodermoclysis of 3 per cent glucose in salt solution is given immediately after operation and this is repeated twice daily until the child is receiving a sufficient quantity of fluid by mouth. The amount of the clysis depends upon the size of the child, varying from 150 c.c. in infants to 500 c.c. in older children. Food is given if possible after the first twenty-four hours, beginning with clear fluids or diluted milk and gradually adding soft solids. Children do not bear deprivation of food as well as adults. When a

sedative is indicated a small dose of codein is given and repeated when necessary. For abdominal distention I rely on enemata and, rarely, pituitary extract. Practically the only laxative used is magnesia magma in repeated small doses. Persistent vomiting is treated by lavage. Transfusion of blood is a measure of great value in certain cases. In wounds which are closed, dry dressing is sufficient, but in ordinary drainage cases a moist dressing is desirable. In cases of peritonitis a large hot dressing, covering the entire abdomen, may be of advantage.

*Postoperative Complications.*—Secondary abscess is usually in or about the pelvis. This condition may be suspected if the temperature goes up after a period of relatively lower temperature. There may be suprapubic pain, painful micturition, diarrhea and even rectal tenesmus. Rectal examination often affords valuable information. Sometimes the abscess may be reached by gently introducing the finger through the original incision. If this is not possible it is better to wait until the site of the abscess is definitely known. Occasionally it points in the rectum and either ruptures spontaneously or may be punctured through the rectum. Fecal fistulæ are much less frequent since the routine use of rubber dam as drainage material. When they do occur closure is usually spontaneous and operation is only very rarely necessary.

Intestinal obstruction, in my experience, is uncommon as an immediate sequel of appendicitis operations in children. When it does occur ileostomy is often of value as an adjunct to whatever other operative measures are necessary.

*Prognosis.*—If the diagnosis is made promptly and operation carried out forthwith, the outlook is good. The removal of an unruptured acutely inflamed appendix at any time of life should only exceptionally be followed by death. Where the appendix has ruptured the outlook is less favorable and this is particularly true in infants where there is much less tendency to localization of the infection. In my own experience there is a mortality of 20 per cent in acute appendicitis in children under five years and 2.5 per cent from five to fifteen years of age.

**Chronic Appendicitis.**—Chronic appendicitis and recurring subacute appendicitis are considered together. Where there have been recurring attacks of abdominal pain with nausea and vomiting and the pain has been first referred to the epigastric region and later to the right lower quadrant together with some rise of temperature, the diagnosis is relatively clear and the indication for removal is obvious. Where, however, the picture is one of obvious ill health without apparent cause and the symptoms and signs are referred rather indefinitely to the abdomen the diagnosis is more difficult. In these circumstances the appendix should fall under suspicion. Practically the only physical sign of importance is tenderness over the

region of the appendix. Rectal examination rarely affords information of value. In such cases it is usually by a process of elimination that a diagnosis is arrived at and the diagnosis of chronic appendicitis is to be accepted only when every other possible cause for the symptoms has been excluded. Roentgen ray evidence is more valuable in excluding ureteral calculi, early hip and spine disease than it is in affording positive evidence of appendicitis. I am inclined to be skeptical of the diagnosis of chronic appendicitis in children unless there is a history of one or more suggestive attacks. On the other hand, there are undoubtedly instances of an unsatisfactory state of health with vague abdominal symptoms in which there is an obvious improvement after removal of a chronically inflamed appendix.

## RETROPERITONEAL ABSCESS

Infection may occur in the retroperitoneal cellular tissue. This may take place in the loin, the infection arising either from the kidney or the intestine. A primary abscess may also occur in the iliac fossa with symptoms which may be mistaken for those of acute arthritis of the hip or appendicitis. In draining such an abscess it is desirable to avoid opening the peritoneal cavity.

## JAUNDICE IN SEPSIS OF THE NEWLY BORN

Infection of the umbilicus, usually streptococcal, occurs at or shortly after birth. The cord is moist and sloughy and the adjacent skin is red and edematous. Infection extends along the umbilical veins into the portal fissure and then into the liver itself. As a result of inflammation of the cells lining the finer ducts an obstructive jaundice develops. There is, in addition, a bacteremia with widespread septic manifestations, among which are suppurative pleurisy, pericarditis, peritonitis or meningitis.

**Clinical Features.**—The diagnosis is usually obvious. Accompanying the local condition of infection there is severe general reaction, jaundice appears shortly and there may be hemorrhages into the skin and mucous membranes as well as from the gastro-intestinal tract. While the temperature is usually high it may be normal or subnormal. The disease is practically invariably fatal.

**Treatment.**—The best treatment is prophylactic and in the aseptic care of the umbilical stump. In an established case hot dressings for the local lesion with the usual general measures and in addition transfusion of blood offer whatever chance there is.

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## CHAPTER XXI

## SURGERY OF THE ABDOMEN (*Continued*)

### ACUTE INTUSSUSCEPTION

Acute intussusception, or the invagination of one portion of the bowel into another, is the most frequent abdominal emergency in infants and the result of treatment is directly dependent upon prompt diagnosis by the practitioner. Approximately 75 per cent of all intussusceptions occur in the first year of life and 50 per cent in the period from five to nine months. The condition is more frequent in males in the ratio of two to one.

**Etiology.**—There is probably no single definite cause producing invagination of the intestine. The great mobility of the lower ileum, cecum and ascending colon in early life is a predisposing cause. The bowel is more irritable and its muscular action is less well coördinated at this period of development. Undoubtedly perverted peristalsis is one of the ways in which an intussusception may arise. The determining factor is the production of the equivalent of a foreign body within the intestine. Abnormal conditions of the gut wall and new growths do excite the formation of intussusceptions but such forms are rare in infancy. The condition may occur during an attack of ileocolitis.

**Pathology.**—The pathological changes are the result of compression of the vessels of the mesentery. The veins and lymphatics are blocked and become so distended that the walls give way and blood and lymph are poured into the wall of the intestines and on to its surface. The involved intestine becomes edematous and infiltrated and it is this that makes reduction difficult. The surface of the bowel is usually ecchymotic and may be rough and granular. While in a general way the extent of the pathological changes is determined by the duration of the condition yet there may be great individual variation.

**Varieties.**—All intussusceptions may be included in four types, though many minor variants of these types have been dignified with separate names.

1. *Ileocecal.*—Really an exaggeration of the slight degree of invagination normally existing at the ileocecal valve. The invagination progresses at the expense of the colon. A variant of this form is that where the head of the cecum is the last part to unfold.

2. *Enterocolic.*—This includes two forms. In one an intussusception beginning in the ileum near the valve goes through the valve and increases

at the expense of the cecum and colon. In the other the valve is pushed before the intussusception. The majority of cases are included in these two forms.

3 and 4. *Enteric and Colic.*—The other two types, enteric and colic, involve the small intestine and the large intestine respectively. To these types must be added the very rare form originating in inversion of the appendix or of a Meckel's diverticulum.

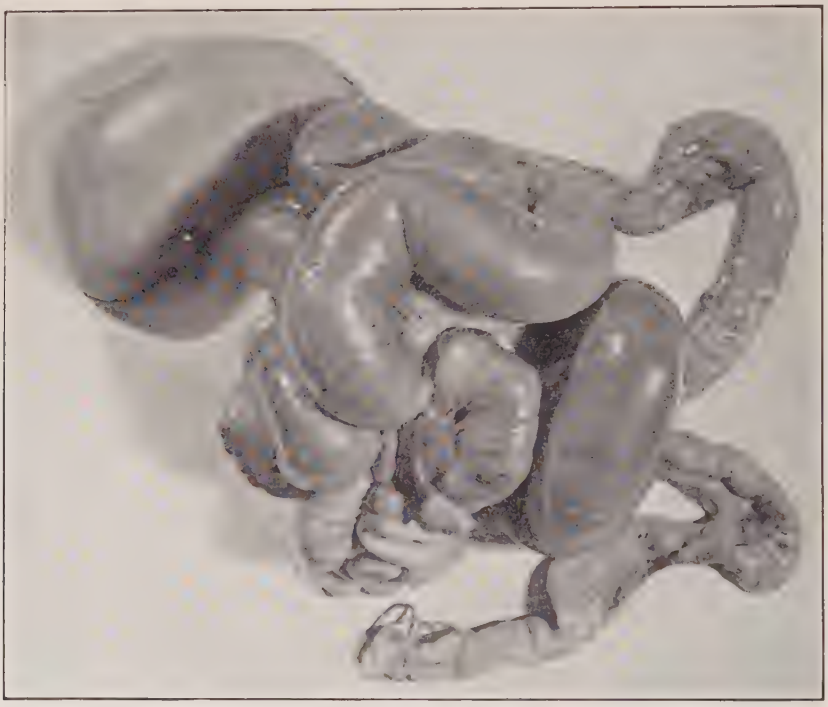

Fig. 176.—Enteric Intussusception.
Specimen removed at autopsy on an infant nine months old.

Intussusceptions are nearly always descending. The term retrograde is applied to those in which the lower portion of the intestine is invaginated into that above it. This form is commonly met with in the postmortem room. It is rarely seen during life and practically always involves the large intestine.

**Clinical Features.**—There is no clinical picture more definite than that of a typical case of intussusception, and, fortunately, the majority of intussusceptions are typical. The onset is sudden. An infant, usually between four and twelve months of age, in good health, often breast fed, screams while nursing or passing a stool and turns pale. He recovers in a short time, only to cry again and draw up his legs as if in pain. Vomiting frequently follows. The child may then have one or more normal stools, but within a

few hours, blood, blood and mucus, or blood mixed with feces will be passed per rectum. After the lower bowel is emptied, blood and mucus alone usually appear. It is very important to remember that, at this stage, between paroxysms of pain, there is usually no elevation of pulse or temperature and the baby may appear little, if at all, ill. He usually, though not always, refuses to nurse. Occasionally attention is first drawn to the condition by the passage of a bloody stool. Obstruction is not always complete and the passage of gas and fecal matter may continue in the presence of an acute invagination. In the beginning, the severity of the symptoms is determined by the degree of interference with the circulation. Later the signs of obstruction appear with distention, toxemia and fecal vomiting.

The physical examination is, in the majority of cases, of secondary importance to the history. It should nevertheless be carefully made in every instance. The most important physical sign is an abdominal tumor which, unless masked by great distention, is usually quite readily found. Certainly its absence cannot be asserted unless an examination under anesthesia has been made. It may be made out in any part of the abdomen, though in early cases it is oftenest situated on the right side or in the epigastrium. The consistence of the tumor is sometimes felt to change during palpation. A rectal examination should be made, but frequently affords little information.

There is a small group of cases occurring in the course of an attack of ileocolitis. While the onset may be acute with all the classical symptoms it is usually insidious and even after the diagnosis is made the duration of the invagination is often in doubt. In this class of patients the tumor is the most valuable and may be the only diagnostic sign. The diagnosis is often exceedingly difficult and I am under the impression that intussusception as a complication of ileocolitis is more frequent than is generally believed. Certain other cases do not conform to the typical clinical picture. This is notably true in enteric intussusception where blood appears in the stools very late and symptoms of obstruction are often the only evidence obtainable.

**Differential Diagnosis.**—Diagnosis in the acute cases usually presents little difficulty. Ulcerative colitis and Henoch's purpura might be confused with intussusception. In the former the stools contain fecal matter, whereas in intussusception they are ordinarily composed of blood and mucus. Henoch's purpura rarely occurs in infants. Its symptoms are purpuric spots, swelling of the joints, abdominal pains, intestinal hemorrhage and vomiting. The abdominal symptoms may precede the purpuric eruption and the joint symptoms. However, the presence of a mass in the abdomen, in a patient suffering from purpura and with symptoms suggesting intestinal obstruction, is sufficient indication for a laparotomy. Roentgenograms after an opaque enema are practically never indicated in acute cases.

**Clinical Course.**—In untreated cases the usual result is gangrene or perforation with a resulting fatal peritonitis. Death may result from intestinal obstruction without peritonitis. In rare instances spontaneous reduction occurs and exceptionally there is spontaneous elimination of the intussusception.

**Treatment.**—Operation is indicated as soon as the diagnosis is made. Where for any reason operation is impossible the best method to employ is an attempt at reduction by hydrostatic pressure. The child is anesthetized and with the buttocks elevated, warm water is allowed to flow through a soft catheter into the rectum from a container held 3 feet above the level of the anus. The passage of water may be followed through the colon by means of abdominal palpation and in favorable cases the intussusception will be felt to unroll.

*Technic of Operation.*—If there has been vomiting and in any case with distention the stomach is washed out preliminary to anesthesia. Where dehydration and prostration are marked, hypodermoclysis of 5 per cent glucose before or during operation is indicated. Ether by the drop method is the anesthesia of choice. The incision is a generous one through the right rectus muscle with the midpoint slightly below the umbilicus. An attempt is made to reduce the intussusception intra-abdominally until the ascending colon is reached when the mass is delivered and reduction is completed under the eye of the operator. It is essential that reduction through the splenic or hepatic flexure of the colon be accomplished intra-abdominally. The reduction should be carried out by squeezing from below upward and expressing the intussusception from its sheath. This maneuver should, if possible, be accomplished by the gloved fingers alone without the aid of gauze, to avoid injurious pressure. Where reduction is difficult the whole mass should be wrapped in a warm, moist pad and by gentle pressure with the hands an attempt made to reduce the edema. Gentle traction upon the entering loop is permissible, rather to direct the expulsion of the mass in the proper axis than to exert traction. A sponge forceps may be introduced between the entering and returning layers at the neck and the blades gently separated. The little dimple which usually forms at the apex of the intussusception should be ironed out. No attempt is made to anchor the cecum but occasionally in the ileocecal type where there is little reaction in the intestine and the tendency to recurrence appears great the ileum and ascending colon may be paralleled by three or four interrupted silk sutures. If an inverted or gangrenous appendix is encountered, appendectomy should be carried out but not otherwise.

Resection is avoided whenever possible and the recuperative power of apparently badly damaged gut is surprising. In performing resection immediate axial anastomosis is preferred. In desperate cases a two-stage opera-

tion, with the removal of the intussusception and an immediate ileostomy, should be attempted. When distention is great ileostomy is occasionally indicated even after reduction. The closure of the wound is important and should be carried out in layers with painstaking care. The dressing is small and retained by long straps of adhesive. There is no indication for drainage.

The postoperative treatment depends on the duration of symptoms before operation. In the early cases it is simple. For the first twelve hours water only is allowed, then diluted breast milk or a suitable formula in small amount for thirty-six hours. By the third or fourth day the infant is back on his regular diet. Hypodermoclysis of 5 per cent glucose is given as indicated. In the event of persistent vomiting gastric lavage is practiced. Pituitrin and enemata are used in distention. A colon irrigation is always given on the first postoperative day. There is frequently a sharp postoperative rise of temperature which usually subsides in thirty-six hours. When there has been much damage to the wall of the gut there is a tendency to colitis and the postoperative feeding is very carefully watched.

*Results.*—While the deaths following operation are usually classed as operative the mortality is not that of the surgeon operating but of the medical community which he serves. In uncomplicated cases operated on within twenty-four hours of the onset of symptoms, the mortality should not be greater than 1 per cent. The mortality increases with each hour's delay after twenty-four hours. When resection is necessary recovery is the exception. There is an occasional case of recurrence of the intussusception but this is unusual and 1 or 2 per cent of the whole number would represent its incidence. When the intussusception occurs during an attack of ileocolitis the outlook is grave.

## CHRONIC INTUSSUSCEPTION

While acute intussusception is a disease of infancy and early childhood, chronic intussusception occurs usually in the adult. The chronic form, in the adult, is usually associated with a new growth, while the acute form in infancy is almost invariably primary. However, chronic primary intussusception does occur in the infant and the symptoms are so obscure and indefinite that consideration of its features is important.

There is a very wide variation in intussusception as to the duration of symptoms in relation to the extent of the pathological process. A sharp division of the various types according to duration of symptoms is difficult, but for practical purposes a case lasting not longer than one week may be considered acute; from one to two weeks subacute, and after two weeks chronic.

Fig. 177.—Roentgenogram after Opaque Enema in a Case of Chronic Ileocecal Intussusception in an Infant Eleven Months Old.

At operation the intussusception was irreducible and resection of the distal ileum, cecum and ascending colon, followed by axial anastomosis of the ileum and transverse colon, carried out. The child recovered after a fairly smooth convalescence.

**Clinical Features.**—Chronic intussusception may develop after an acute attack has subsided or may occur as such from the beginning. The initial symptoms may appear suddenly or the onset may be gradual. Recurring cramplike abdominal pain lasting for a few seconds and recurring every hour or so is the most characteristic symptom. The pain comes on suddenly and ceases suddenly, the child appearing little the worse during the intermission. Vomiting is infrequent and if it occurs it is usually at the onset. There may be passage of mucus and blood—this is also usually early in the attack. Later there may be constipation but stools more or less normal are passed, the obstruction is not complete and there is usually little tendency to distention. A very characteristic feature is a rapid loss in weight. Indeed, this may be the feature which causes the child to be brought to the doctor and it is incidentally brought out that the child has been fretful and has apparently suffered from abdominal cramps.

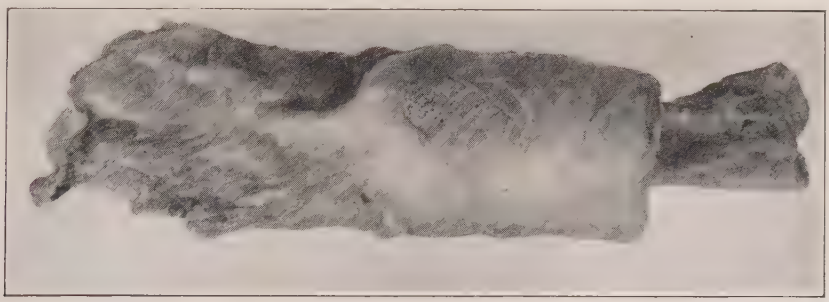

Fig. 178.—The Specimen Removed in the Same Case as in Figure 177.

**Diagnosis.**—The presence of an abdominal tumor varying in position and consistency (depending on the contraction or relaxation of the walls of the intestine or not) may usually be demonstrated but frequently examination under anesthesia or during sleep is necessary. Roentgen ray examination after an opaque enema is of great value and may afford the only definite evidence of the condition.

The condition may easily be confused with tuberculous peritonitis. An unnatural emptiness in the iliac fossa associated with a tumor in the epigastrium aids in differentiating chronic intussusception from tuberculous peritonitis with a thickened, rolled omentum.

**Treatment.**—Operation is indicated. When reduction is possible and the vagination is of the ileocecal variety as it usually is, the ileum and ascending colon should be paralleled by means of three or four interrupted silk sutures. Unfortunately reduction is sometimes impossible and resection is to be preferred to a short-circuiting operation. Axial anastomosis is the best method and the hypertrophy and dilatation of the proximal small intestine renders this technically easy.

*Results.*—When reduction is possible the result is usually good. In the event of resection the outlook is serious but less so than in the acute variety.

## INTESTINAL OBSTRUCTION

In intestinal obstruction there is a mechanical impediment to the passage of the intestinal contents through the lumen of the bowel. The obstruction may be complete or incomplete, acute or chronic. Opposed to this is paralytic ileus in which condition there is no mechanical obstruction to the lumen but there is a lack of propelling force due to paresis or paralysis of the muscle in the walls of the intestine as a result of inflammatory process (peritonitis) or interruption of the blood supply. In infants, at birth or within a few days, intestinal obstruction usually means an imperforate anus, congenital atresia of the intestine or congenital volvulus. After this period and up to two years intussusception is the most frequent cause of obstruction. Characteristic of this period also, but much less frequent, are acute volvulus and various pathological results of a persistent Meckel's diverticulum. An adherent Meckel's diverticulum may serve as a pivot around which a portion of the small intestine rotates. Enteric and mesenteric cysts may result in subacute or chronic obstruction. After two years obstruction is most frequently due to strangulation of an internal or external hernia. Postoperative obstruction from bands and adhesions occurs next in frequency. Volvulus, usually limited to the cecum, ascending colon and adjacent ileum, may occur.

**Pathology.**—The changes in the bowel consequent on an obstruction vary widely and depend largely upon the nature and duration of the obstruction. The intestine below the site of obstruction is collapsed and empty, that above is dilated and at first thin and pale, later congested and edematous, and small areas of hemorrhage appear in the mucous membrane. Still later superficial erosions appear and organisms pass through the wall and set up a peritonitis. If the obstruction is subacute or chronic in course there is hypertrophy of the walls due to the efforts of the muscular layers to overcome the obstacle to the passage of the intestinal contents. When the circulation is obstructed the involved loop is deeply congested, dark purple in color, and rapidly becomes tense from edema. There is a bloody exudate into the lumen of the bowel and into the peritoneal cavity. Gangrene may ensue in a few hours if the circulation is completely shut off and the wall of the bowel loses its shiny appearance and becomes soft and flaccid.

**Clinical Features.**—The clinical picture is the sum of three groups of symptoms: (1) The results of obstruction to the lumen, constipation, vomiting, distention and colicky pains resulting from increased peristalsis; (2) shock with its symptoms of pallor, sweating and lowered blood-pressure;

(3) toxemia from the absorption of poisonous materials from the lumen of the bowel. It depends upon the nature and duration of the obstruction which group of symptoms dominates the picture. It is noteworthy that in a child intestinal obstruction is usually accompanied by strangulation of the circulation of the involved bowel and the small intestine is most frequently affected. The onset of symptoms may be abrupt or gradual and is first manifested by abdominal pain, recurring at regular intervals, referred usually to the umbilicus. This pain may be mild or severe. Vomiting soon occurs, is repeated and after varying lengths of time the vomitus consists of upper intestinal contents and has a fecal odor. The fluid is not really fecal, its odor is due to bacterial decomposition and the odor may be as offensive in a high obstruction as it is in one lower down. Constipation is present though the bowel below the obstruction is often emptied shortly after the onset of symptoms. When the obstruction is of long duration visible peristalsis may be noted. Tenderness is usually not marked. In high obstruction the vomiting is early and repeated and distention is not marked. In lower obstruction vomiting is usually not so marked a feature and abdominal distention is uniform and progressive. The symptoms of shock may occur at the onset and they are particularly marked where strangulation has occurred. There is a rapid loss of fluids from the constant vomiting with resulting dehydration, and acidosis may ensue. As time passes toxemia from the absorption of toxins developed in the intestinal contents occurs and is manifested by rapid, feeble pulse, cold, clammy skin and subnormal temperature. The face is pale and eyes are sunken but the patient frequently remains conscious and alert to the end. Associated with this toxemia is a retention of sodium chlorid in the tissues. The rapid transition from a stage in which the patient appears to be in good condition to that pictured above is particularly marked in children.

**Diagnosis.**—The initial symptoms may resemble those of other acute abdominal conditions. Diagnosis of obstruction is based on persistent colicky abdominal pain, vomiting, inability to pass feces or flatus and increased peristalsis. In some cases the site of the lesion may be determined. In intussusception the presence of a tumor suggests the nature of the obstruction. The history, as of previous operation, may throw light upon the possible cause. The hernial sites should always be inspected and the possibility of diaphragmatic hernia indicates examination of the chest.

**Prognosis.**—With the exception of congenital malformations in which the outlook is usually poor the element of time practically determines the outcome. Early diagnosis and prompt operation usually result in a cure.

**Treatment.**—Treatment consists in operation at the earliest possible moment. Certain measures are of value as a preparation for operation.

Gastric lavage should invariably be carried out before anesthesia is administered. If there has been much loss of fluid hypodermoclysis of physiologic salt solution is indicated. When the site of obstruction is not known a right midrectus incision with its midpoint just below the umbilicus should be made. When the abdomen is opened, inspection of the cecum will indicate whether the large or small intestine is involved. When the site of obstruction is reached it should be relieved if possible. If there is great distention of the bowel above, a 16 F or 18 F catheter should be introduced into the lumen of the gut in such a manner as to pass through the wall obliquely. If it is impossible to relieve the obstruction it is better to introduce the catheter and not attempt any short-circuiting operation in the presence of distention. The condition producing the obstruction may be relieved later on.

*Postoperative Treatment.*—Hypodermoclysis of salt solution twice a day until sufficient fluid is being taken by mouth. Where toxemia is evident the administration of salt solution is very important on account of the altered sodium chlorid metabolism. Very frequently it will be found that there is very little drainage from the catheter for the first twenty-four or forty-eight hours. To insure that the lumen is patent a small amount of salt solution may be carefully injected with a syringe. When the obstruction has been relieved and a catheter inserted it is probably just as well to refrain from using pituitrin and enemata and to rely on keeping the patient comfortable and supplied with an adequate amount of fluid. In toxemia persisting after operation a transfusion may be of benefit.

## MEGACOLON [1]

Under the terms congenital dilatation of the colon, Hirschsprung's disease and the more general one of megacolon, are grouped a number of conditions affecting the colon. These conditions are characterized anatomically by a total or segmentary dilatation of the large intestine with hypertrophy of the walls in the dilated zone. The term "true" megacolon is applied to those cases manifesting symptoms in infancy and early childhood and "pseudo" megacolon to those cases occurring in later childhood and adult life.

There are many theories in regard to the etiology of the condition but no single cause thus far discovered satisfactorily explains every case. Possibly in "true" megacolon the essential fault is anomaly in the nervous mechanism with a resulting depression of the reflex which causes contraction of the lower colon as a result of contact of the mucus membrane with fecal matter.

[1] This section has been adapted from an article in the *Annals of Surgery*, 1927, 86: 62.

It is convenient to divide into two classes the conditions which are grouped under the general term megacolon. True Hirschsprung's disease, congenital idiopathic dilatation of the colon, is rarely observed. A proportion of the cases reported as such prove, on analysis, to be instances of more or less localized involvement of the colon in which there is evident the element of mechanical obstruction, anatomical or functional. Slight degrees of the congenital defect may apparently exist for years with few or no symptoms. Recognition may be due to accident or to the development of symptoms later in life.

In its typical form the condition is characterized by obstinate constipation with abdominal distention. The constipation is obstinate and weeks may pass without a bowel movement although flatus escapes freely. Temporary relief is obtained from enemata. The movements are often not formed and may be very offensive. Sometimes attacks of diarrhea alternate with constipation. The abdomen enlarges, becomes prominent and visible peristalsis may be noted attended with loud borborygmi. Vomiting is not usually present. At first there may be little alteration of the general health but sooner or later the general nutrition suffers and the child becomes pale and toxic. The constipation is often noted from birth and abdominal distention may be present at birth but more frequently appears in the second month or later. The greater number of these patients die in early childhood, but some reach adult life and even old age. The prognosis depends upon the extent of involvement and upon the age of the patient. The younger the individual the more unfavorable the prognosis. The involvement is usually most marked in the sigmoid colon, but the entire large intestine or any portion of it may be the seat of disease. Exceptionally a normal segment of intestine is present between two dilated portions. The rectum may be involved but is usually normal. Males predominate in the proportion of three to one. Diagnosis is rarely difficult.

Fig. 179.—Congenital Idiopathic Dilatation of the Colon (Hirschsprung's Disease) in a Boy Two Years Old.

Congenital stricture of the rectum may result in a condition similar in some degree to the so-called idiopathic dilatation of the colon. It is therefore essential in all cases to exclude the presence of such a stricture. Tuberculous peritonitis, chronic intestinal indigestion and rickets are con-

ditions mentioned as causing confusion. Roentgenography after an opaque meal is practically always conclusive.

The outlook is poor whatever the treatment, but inasmuch as compensation is occasionally established, a careful trial of medical measures is

Fig. 180.—Roentgenogram after Opaque Enema in Same Case as in Figure 179.

indicated. Such measures include a supporting abdominal belt, a low residue diet with restriction of starches, the avoidance of laxatives with the exception of mineral oil and the daily use of high enemata. Massage, electrical treatment and the administration of atropin may be

Fig. 181.—Megacolon roentgenogram after Opaque Enema in a Boy of Thirteen Years.

employed. Dilatation of the anal sphincter sometimes proves of advantage. Even where medical measures appear efficacious it is reasonable to assume that there will be a gradual progression of the condition and as middle age is approached there will be greater and greater difficulty in emptying the bowel. However, if surgery is undertaken, nothing less than total colectomy or ileosigmoidostomy with exclusion and drainage of the colon will be

FIG. 182.—ROENTGENOGRAM TWENTY DAYS AFTER OPAQUE MEAL IN A CASE OF MEGASIGMOID AND MEGARECTUM IN A BOY OF FIFTEEN YEARS.

Intestinal stasis with fecal impaction resulting in megacolon.

adequate. There is little available knowledge as to the late results of these measures. Therefore it is advisable to continue medical measures until there is increasing difficulty in emptying the colon, at which time operation should

FIG. 183.— ROENTGENOGRAM AFTER OPAQUE ENEMA IN A BOY THIRTEEN YEARS OLD.

Redundant sigmoid with fecal stasis results in segmentary dilatation of the colon. Medical treatment is indicated.

be undertaken. Where the parents are not sufficiently responsible to carry out the necessary measures or are unable to do so, operation is indicated at once.

Operation should be avoided if at all possible in the presence of obstructive symptoms and a bowel distended with feces. When operation under such circumstances is inevitable a preliminary colostomy may be indicated. Ordinarily, however, more radical measures give better results.

Procedures varying in extent from ileosigmoidostomy to total colectomy in one stage with the implantation of the ileum into the rectosigmoid have been advocated. The sequence practiced by Sistrunk, Hubbard and others appears, on the whole, to be the most promising. Following a lateral anastomosis between the ileum and the sigmoid the ileum is cut across and both ends closed. Just above the anastomosis the sigmoid is divided, the distal end closed and the proximal end brought out in the upper portion of the abdominal incision to drain the excluded large intestine. The entire colon may be removed at a later date if the inconvenience of the fistula is such as to warrant this measure. Where the entire colon is not involved the procedure employed by Finney is applicable. This consists in a preliminary colostomy in healthy bowel. Subsequently a lateral anastomosis between the segments immediately above and below the distended portion is made and after complete recovery resection of the affected colon may be carried out.

To the second class, that of pseudo or acquired megacolon, belong by far the greater number of cases. The patients suffering from this condition usually come under observation later in childhood or in adult life. This type of megacolon may occur as a result of varied conditions but is most frequently consecutive to a mechanical obstruction. The obstruction may be congenital, but the dilatation and hypertrophy of the large bowel is secondary and does not usually manifest itself in infancy. Redundancy of the sigmoid colon, with subsequent rotation or angulation, may result in chronic obstruction and consequent megacolon. A valve of mucosa may form at the point of angulation. Intestinal stasis with fecal impaction in the rectum is a further frequent cause. It is possible that the intestinal stasis is due to a congenital defect in musculature or innervation.

This group offers the most intricate problems in the selection of suitable treatment. To begin with there is a wide difference of opinion as to what degree of dilatation of the large intestine constitutes megacolon. Symptoms may be practically absent in a patient in whom roentgenography reveals an apparently greatly dilated colon but may be very marked in another patient whose colon seems only moderately involved. Then, too, normal or redundant sigmoid may be so distended by the injection of fluid under pressure, as to present a very deceptive picture. Few observers have had the opportunity of reporting on an extended series of personal cases. With rare exceptions, little emphasis has been placed on the end results of treatment and there are available few well-grounded conclusions, helpful in dis-

Fig. 184.—Roentgenogram after Opaque Enema in a Boy of Thirteen Months with Congenital Stricture of the Rectum.

Megacolon has resulted. Relief of stricture is indicated.

criminating between the indications for medical and those for surgical treatment. Save in the presence of acute obstructive symptoms the first step in the treatment should consist in the correction of any anatomical cause

of obstruction. It is true that, even though the obstruction be removed, medical measures will only exceptionally restore to normal a definitely dilated and hypertrophied colon. Careful medical treatment does, however, enable many patients with a very marked degree of megacolon to carry on their lives with little inconvenience from the condition. Such patients are obviously not subjects for radical surgery.

If medical treatment fails an operation such as that described in congenital dilatation of the colon is indicated.

Surgery has its most favorable field where the rectum is normal and there is segmentary dilatation of the colon. The entire diseased segment should be removed and operation in two or three stages is the method of choice though resection in one stage may be done in very favorable cases.

No general rule for the treatment can be formulated. Type and degree of involvement, and to some extent the social status of the patient, must be carefully weighed. Medical and surgical treatment each have their indications and limitations and the treatment of the individual case must be decided solely on the merits of the case.

## LIVER AND BILE-DUCTS

### Surgical Aspects of Jaundice

In a very large proportion of infants jaundice is noted, appearing usually on the second to fifth day and lasting from a few days in the mild to many weeks in the severe cases. The skin varies in color from a pale to an intense yellow. The urine usually is normal and only in severe cases does it contain an appreciable amount of bile. The stools are normal. There are usually no other symptoms than jaundice and the condition is practically never serious. The explanation of this event is a matter of dispute and it may properly be spoken of as "physiological jaundice."

**Congenital Atresia of the Bile-Ducts.**—In a smaller number of infants, jaundice appearing at this time is of serious import indicating, as it does, a congenital malformation of the bile-ducts. The jaundice usually appears soon after birth and steadily increases until it becomes intense. Even in complete obstruction the jaundice may not appear for several days. This is explained by the fact that the liver normally produces little bile pigment until birth and also has a capacity for storing a certain amount. The serious nature of the condition is evidenced by the passage of pale or white stools. Examination will show that these stools do not contain bile or that it is present only in traces. While the white stool is usual a deceptive coloring may be occasioned by bacterial action and a chemical examination is necessary before the absence of bile is detected. The urine is highly colored and contains bile in large amounts. The liver and spleen may be

FIG. 185.—CONGENITAL CYSTIC DILATATION OF THE COMMON BILE-DUCT IN AN INFANT FIVE MONTHS OLD.

Roentgenogram after opaque meal showing displacement of duodenum by cyst. At operation the cyst contained one pint of bile. A choledochoduodenostomy was done. Death occurred eighteen days after operation as a result of advanced biliary cirrhosis. Early diagnosis and operation probably would have saved this infant.

enlarged. The jaundice deepens until the skin assumes a greenish yellow hue which is very striking. There may be hemorrhages into the skin or mucous membranes or from the umbilicus. Death occurs usually within the first four months.

*Pathology.*—The pathology is varied and minor abnormalities, especially those affecting the cystic duct, occur with great frequency. The ducts

may be partially obstructed, they may exist as fibrous cords or they may be absent in whole or in part. The gall-bladder may be rudimentary or, more rarely, much dilated. Clinically those cases involving the common duct, or more rarely the hepatic ducts, are of importance. When the common duct is affected there may be stenosis or atresia at any point in its course and unusual weakness of the walls above the obstruction may result in enormous dilatation of the duct—"congenital cyst of the common duct." Holmes has shown that in over 16 per cent of the cases of atresia of the bile-ducts both the cystic and hepatic ducts are essentially normal and communicate with each other. In this proportion of cases the condition is at least theoretically amenable to surgical treatment, which consists in an anasto-

Fig. 186.—Specimen Removed at Autopsy in Same Case as in Figure 185.

mosis between the distended portion of the duct or the distended gall-bladder and the stomach or duodenum. It is essential for a successful result that the diagnosis be made as early as possible. In cases which have persisted for a long period there is set up a marked biliary cirrhosis which results in death even if the obstruction is relieved.

*Differential Diagnosis.*—The condition is differentiated from interstitial hepatitis of syphilitic origin by family history and negative Wassermann reactions. Hemolytic family jaundice may be excluded by chemical examination of the urine and feces and by the normal fragility of the red cells. Jaundice from umbilical sepsis is differentiated by the character of the temperature curve, the widespread inflammatory reactions and bacteremia.

*Treatment.*—Although only a relatively small proportion of these infants present a malformation which is suitable for surgical relief, exploratory operation is indicated whenever the diagnosis seems reasonably clear. When, associated with jaundice, a definite tumor can be palpated in the

region of the liver, an exploratory operation is clearly indicated at once. Where possible the gall-bladder or other structure is utilized to form an anastomosis with the duodenum or stomach. If this is not feasible an external fistula may be established with a view to subsequent repair. One or two transfusions should precede the operation to counteract the tendency to hemorrhage.

**Cholelithiasis—Cholecystitis.**—These conditions are rare in childhood but not unknown and a number of cases have been reported. They are usually associated but may exist separately. While the etiology is not known there is no reason to assume any difference from that in adults. The association with typhoid fever is also noted in children. Occasionally

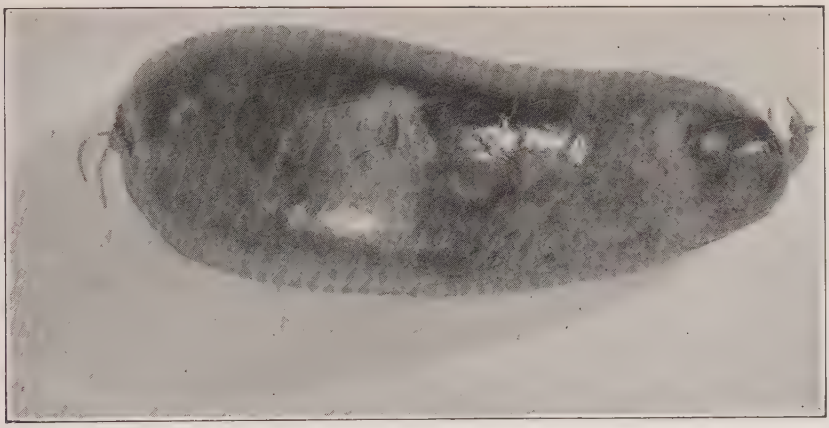

FIG. 187.—SPECIMEN REMOVED IN CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS IN A GIRL SEVEN YEARS OLD.

a round-worm penetrates into the bile passages and sets up an inflammation there.

The symptoms of gall-stone colic in children are probably identical with those in adults but are rarely elicited. In the only instance of acute cholecystitis in a child which has come under my observation, the clinical picture of the disease was typical of that in the adult. However, the possibility of inflammation of the gall-bladder did not occur to me and I went out of my way to make a diagnosis of undescended cecum and acute appendicitis. The patient was a girl of seven and I removed the distended and inflamed gall-bladder. There were no stones. Unless the condition of the child is excellent and the operation appears technically easy I should content myself with drainage of the gall-bladder.

The possibility of gall-stones is to be borne in mind but their presence is so rare as not to warrant, in my opinion, the routine exploration of the bile tract in abdominal operations in children.

Both benign and malignant tumors of the liver are found in childhood but are rarely amenable to surgical treatment. Where such a diagnosis is made an exploratory operation should be carried out because of the possibility of error. If a tumor of the liver is found which is not removable

FIG. 188.—DERMOID CYST REMOVED FROM A GIRL SIX YEARS OLD.

The cyst was inflamed and impacted in the pelvis. The preoperative diagnosis was appendical abscess. (Case of E. J. Donovan.)

surgically, as is usually the case, a biopsy should, if possible, be done and radiotherapy instituted.

**Pancreatitis.**—Pancreatitis is exceptional but does occur and differs in no respect from a similar condition in adults. Symptoms of acute abdominal disease with rapidly increasing distention and an elongated mass across the epigastrium suggest pancreatitis.

*Treatment.*—Operation is indicated and if pancreatitis is found the pancreas should be approached either from above or below the stomach.

the capsule incised and a rubber-dam drain led out through the abdominal wound.

## PRIMARY SPLENIC ANEMIA AND GAUCHER'S DISEASE

Certain conditions characterized by an enlarged spleen are benefited by its surgical removal. Hemolytic jaundice and thrombocytopenic purpura have been considered. There remain primary splenic anemia (Banti's disease), von Jaksch's anemia and Gaucher's disease. The second is probably not an independent condition but a variant of the first. The third is very rare and is only definitely diagnosed by a microscopic examination of the spleen. Each condition has been described at length in another volume of this series. I merely wish to point out the indications for splenectomy and to call attention to the fact that these conditions may be met with in early childhood. Given a child with an enlarged spleen, a blood-picture of secondary anemia and evidence of blood destruction, the question of the advisability of splenectomy at once arises.

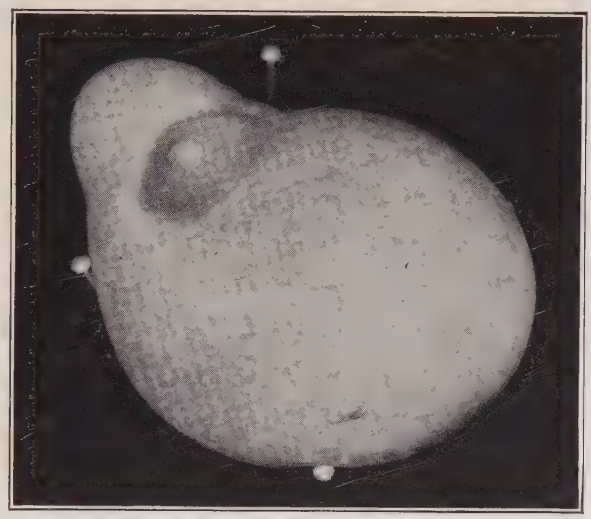

FIG. 189.—SIMPLE OVARIAN CYST, FREE IN PERITONEAL CAVITY OF THREE MONTHS OLD INFANT, REMOVED AT OPERATION.

Spontaneous separation as a result of torsion seems the probable explanation.

Certain conditions also characterized by enlarged spleen must be excluded; prominent among these are leukemia, malaria, syphilis, tuberculosis and rickets, in none of which is splenectomy indicated. If these other diseases associated with enlarged spleen are excluded and there is no improvement in the blood-picture after repeated transfusions, splenectomy is indicated.

**Results.**—If the spleen is removed in the early stage of Banti's disease, the outlook is good for a permanent cure. If in the later stages after the appearance of ascites, the condition is improved but a cure is doubtful. If the condition proves to be Gaucher's disease there is a more or less temporary improvement but as the pathologic condition probably develops simultaneously in the bone marrow, lymph-nodes, etc., there is little hope for a permanent cure.

FIG. 190.—SIMPLE OVARIAN CYST CONTAINING TWO GALLONS OF FLUID REMOVED FROM A GIRL OF FOURTEEN YEARS.

Diagnosis of enlarged spleen is not usually difficult as the situation and notched border are usually characteristic. It is sometimes difficult to differentiate a very large tumor of the left kidney. When there is doubt inflation of the colon will serve a useful purpose as the colon will be made out to pass in front of the kidney tumor.

## TUMORS OF THE OVARY

Solid or cystic tumors of the ovary are among the more common abdominal tumors in children. About one-half of these tumors are benign simple cysts or dermoids, the remainder are malignant, sarcoma or carcinoma, the latter type being very unusual. They may occur at any age.

A swelling in the lower abdomen is, as a rule, the sign or symptom to call attention to the presence of an ovarian tumor. In many cases, however, abdominal pain resulting from torsion of the pedicle is the first symptom noted. Not infrequently a diagnosis of acute appendicitis is made. In the malignant tumors constitutional symptoms and loss of weight may be the first indication. Particularly in the simple cysts the growth may reach such dimensions as to interfere with respiration.

Fig. 191.—Ovarian Cyst in Infant Seven Months Old.
(Case of Wm. A. Downes. Courtesy *J. Am. M. Ass.*)

The diagnosis is often difficult. The cyst may be attached by a very long pedicle and be mistaken for a hydronephrotic kidney or a mesenteric cyst. Bimanual examination with one finger in the rectum is a valuable aid. In the large cystic tumors occupying almost the entire abdominal cavity, differentiation from ascitic tuberculous peritonitis, omental or mesenteric cyst may be difficult. Roentgen ray examination after an opaque meal or enema aids in determining the relation of the intestine to the growth. In tuberculous peritonitis the summit of the abdomen is often tympanitic, while in ovarian or other encysted collection of fluid this region is flat.

Treatment is of course surgical and operation should be done as soon as possible. In this connection it is well to remember the possibility of twisted ovarian cyst simulating an acute appendicitis. When in the pres-

ence of acute abdominal symptoms in girls a diagnosis of acute appendicitis is made, the abdomen opened and a normal appendix found, the pelvis should be explored.

FIG. 192.—ENTEROGENOUS MESENTERIC CYST CAUSING CHRONIC INTESTINAL OBSTRUCTION IN AN INFANT FIVE WEEKS OLD.

Resection of the cyst with about 5 inches of ileum. The child has developed normally and is now seven years old.

## OMENTAL AND MESENTERIC CYSTS

Cysts of varied origin, but usually lymphatic, may rarely be observed in the omentum or mesentery. In the smaller cysts a correct diagnosis may occasionally be made but when the cyst attains such a size as to fill the abdominal cavity its recognition before operation is almost unknown. In

the smaller cysts the situation and great mobility are suggestive and sometimes the relation of the intestine to an underlying mesenteric cyst may be made out. In the larger cysts the same diagnostic procedures are indicated as in large ovarian cysts.

Treatment is operative and the prognosis is good.

## ENTERIC CYSTS

Cysts arising in the wall of the intestine and projecting into the lumen may result in intestinal obstruction directly, or indirectly, by forming the

Fig. 193.—Enteric Cyst Causing Acute Intestinal Obstruction in an Infant Twenty-three Days Old.

apex of an intussusception. Such cysts may be single or multiple and occur most frequently in the region of the ileocecal valve. The diagnosis is rarely made before operation.

**Treatment.**—Ordinarily the cyst should be removed by resection of the involved intestine. In certain instances, however, when resection is not warranted, an enterostomy with excision of the projecting portion of the cyst with suture of the cut edges will suffice.

## SARCOMA OF THE INTESTINE

Exceptionally a sarcoma of the intestine is met with, usually in the small intestine. In such cases there is a solid or cystic growth arising in the submucous layer and covered with intact mucous membrane. The tumor may be polypoid and form the apex of an intussusception.

Treatment is operative but the outlook is poor as there are usually rapid metastases to the related lymph-nodes and to the liver.

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## CHAPTER XXII

## THE RECTUM AND ANUS

### MALFORMATIONS

**Development.**—In early fetal development the urogenital organs and the terminal part of the bowel open into a culdesac called the cloaca which is analogous to the cloaca of birds and reptiles. About the second month this cloaca is divided by the growth of a longitudinal septum into two compartments, of which the anterior is the opening of the urogenital organs while the posterior portion becomes the rectum. Imperfect development of the longitudinal septum results in the varied types of abnormal communication between the rectum and bladder, urethra or vagina. Coincidentally with the development of the rectum there appears in the epiblast a depression called the proctodeum, situated in line with the rectum but separated from it by a septum called the cloacal membrane. The continuity of the rectum and anal canal is established by the disappearance of this membrane.

Malformations of the anus and rectum are infrequent, occurring once in ten thousand births, but the subject is of great interest as the condition must be treated promptly and with decision.

**Varieties.**—1. *Malformation of the Anus.*—There may be a narrowing of the anal canal with the anus in its normal situation. The presence of the anus in its normal situation may lead to confusion until a digital examination is made. Attention is directed to the condition by the child having difficulty in defecation and crying and straining during the act. The stricture may be annular or tubular. In the former, simple division is all that is necessary; in the latter a linear incision with subsequent dilatation by means of bougies.

The anus may be imperforate with a narrow tract extending forward from the rectum to open just behind the scrotum. Attention is directed to this by the symptoms referred to above and on inspection there is apparent a narrow fistulous opening just behind the scrotum. Treatment consists in making an opening through the normal site of the anus and dissecting out the tract extending forward.

The most common malformation of the anus is its occlusion by a thin membrane. This membrane bulges and sometimes the meconium may be seen through it. In this form a simple crucial incision, with trimming of the edges, is sufficient to cure the condition.

The anal canal may be absent. In such cases there may be no indication of its position or the site may be marked by a dimple.

The anus and the anal canal may be normal but separated from the rectum by a thin membrane.

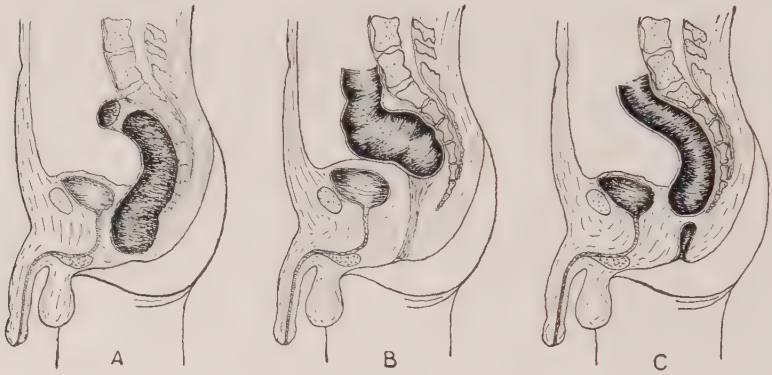


FIG. 194.—VARIETIES OF MALFORMATION OF ANUS AND RECTUM.

*A*. Imperforate anus, occlusion by thin membrane.
*B*. Absence of rectum and anus, colon ends in culdesac.
*C*. Anal canal present but separated from the rectum by a bridge of tissue.

In other cases there may be merely a depression with a ridge of fibrous tissue of varying thickness intervening between the anus and rectum.

2. *Malformations of the Rectum.*—There may be complete absence of the rectum, the colon ending in a culdesac. The anus may be absent or present and separated from the colon by a thick bridge of tissue.

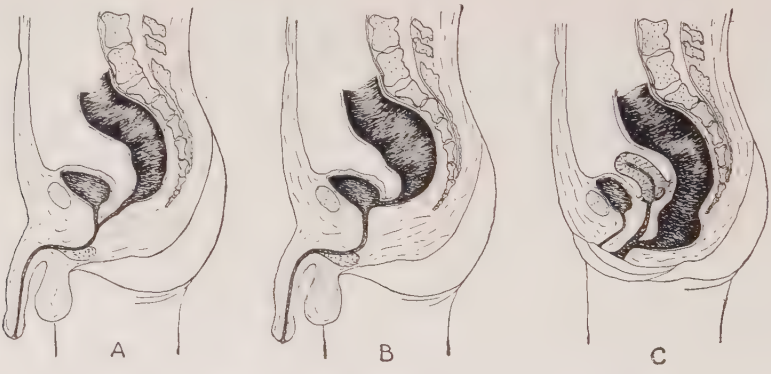


FIG. 195.—VARIETIES OF MALFORMATION OF ANUS AND RECTUM.

*A*. Imperforate anus, rectum communicates with urethra.
*B*. Imperforate anus, rectum communicates with bladder.
*C*. Vaginal anus.

More commonly the rectum, fully formed, does not communicate with the anal canal, the separation varying in extent. Rarely a pouch of peritoneum intervenes.

The rectum may communicate with the bladder, the urethra, the vagina or the vulva. The latter communication is the most frequent and may cause so little trouble as not to be discovered during childhood.

When the rectum opens into the bladder, feces mixed with urine escape during micturition. When the opening is into the urethra gas and feces escape independently of micturition.

**Treatment.**—When there is complete obstruction operation should be undertaken as soon as the condition is discovered. A simple crucial incision and removal of the flaps so formed will suffice when there is occlusion by a thin membrane. In other cases a vertical incision, beginning just behind

FIG. 196.—IMPERFORATE ANUS.
Note bulging of perineum.

the scrotum and extending to the coccyx, is made. The coccyx itself may be removed. Progress is made upward, keeping close to the sacrum (and so avoiding the urethra and bladder). If the child is allowed to strain and cry the ampulla may bulge into the wound. When it is located it is gradually freed from the surrounding parts and if possible brought down to the anal site, opened, and the edges of the mucous membrane sutured to the skin, an attempt being made to locate the opening in the area where the external sphincter is situated. When there is a septum between the anal canal and the rectum operation should proceed on similar lines. If the ampulla cannot be located there is nothing left but a left inguinal colostomy. When the bowel opens into neighboring regions the need for operation is not so urgent. Where the communication is with the bladder or urethra the certainty of an ascending pyelonephritis must be recognized and opera-

tion is not to be delayed unduly. An effort is made to locate the ampulla and open it at the normal anal site in the hope that the rectovesical or recto-urethral fistula will close. Where there is a vulvar or vaginal anus with sufficient discharge of feces operation should be deferred until the child is six or eight years old. The operation consists in transplanting the existing opening to the normal anal site.

*Results.*—When an adequate opening in, or approximately in, the normal anal site can be produced the results are good. When there is just a thin membrane they are practically perfect. In other cases control is often not perfect. When the rectum is separated from the anal canal by a thick layer of tissue the mortality is high and when an inguinal colostomy is necessary

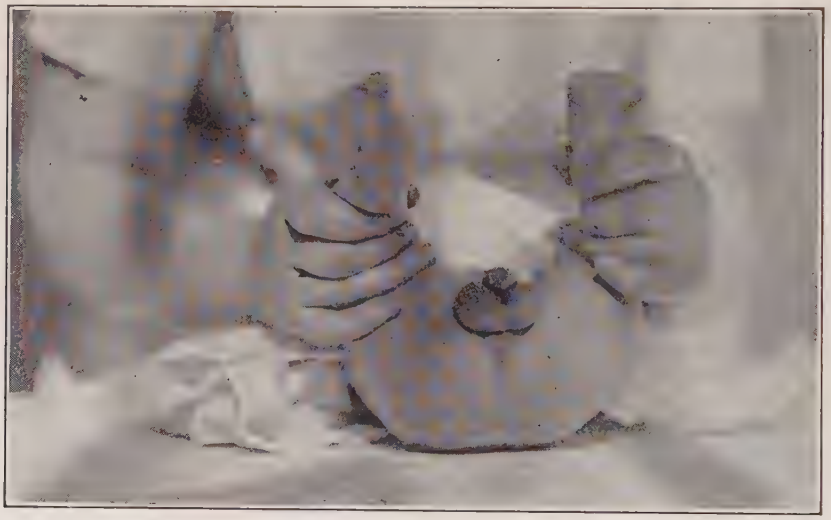

FIG. 197.—ABSENCE OF RECTUM, COLON ENDS IN CULDESAC, NO BULGING OF PERINEUM.

the infant rarely survives. At times an inguinal colostomy is indicated as a preliminary measure with a view to subsequent procedures, as when there is communication between the rectum and bladder.

Stenosis of the rectum and anus may result in varying degrees of megacolon. On relief of the stenosis the colon quickly resumes normal proportions, unless the condition has existed for several years. In the latter case the megacolon may persist in spite of the relief of the obstruction.

## RECTAL POLYP

This is the only tumor of the rectum occurring with any degree of frequency in young children. It is a benign adenoma, single or multiple, pedunculated, situated usually on the posterior or lateral walls of the rectum

within easy reach of the finger. It is at first sessile, later developing a long pedicle from the downward drag to which it is submitted. The tumor is soft, varying in size from that of a pea to a cherry and is dark red in color. It most frequently occurs between the second and fifth year.

**Clinical Features.**—Rectal tenesmus and the presence of blood and mucus in the stools are the usual features. The tumor is usually easily recognized on digital examination, particularly if care is taken to sweep the finger over the whole surface of the interior of the lower rectum.

**Treatment.**—If the polypus is easily brought to the anus, the stalk should be ligated and the tumor removed. It is probably desirable to transfix the pedicle, to prevent slipping of the ligature and consequent hemorrhage. If it is not easily reached the sphincter should be dilated under ether anesthesia and the tumor removed as described. Not infrequently the tumor is extruded spontaneously.

## ANAL FISSURE

Anal fissure may occur in infants and children, often as the result of constipation, the mucous membrane being abraded or torn in the passage of a hard fecal mass. It is usually situated on the posterior wall.

**Clinical Features.**—The characteristic feature is pain on defecation. Constipation may initiate the condition, later it becomes voluntary on account of the pain. There may be a streak of blood on the stool. On examination the sphincter is spastic and it is usually impossible to demonstrate the ulcer until the sphincter has been dilated.

Treatment consists in measures to correct constipation and keep the stools soft. Mineral oil given with the food is probably the best method. Locally a bland ointment is applied. Should these measures fail, dilatation of the sphincter under anesthesia is indicated. It is important that after this the stools be kept soft for several weeks.

## PROLAPSE OF THE RECTUM

The term prolapse is applied when any portion of the rectum protrudes beyond the anus. When mucous membrane alone protrudes the condition is spoken of as incomplete prolapse, as opposed to complete prolapse when all coats of the bowel are involved. In an extensive rectal prolapse the pouch of Douglas may be dragged down forming a potential sac, into which intestine may herniate.

**Etiology.**—Usually several factors contribute to the production of prolapse. Undue laxity of the perineal and rectal tissues associated with any cause of excessive straining is the most constant combination. For

instance, after a long-continued illness when the muscular support becomes weakened and relaxed and the fat pads about the rectum disappear, any cause producing straining such as constipation, diarrhea or rectal polyps may result in prolapse. The habit of allowing a child to sit indefinitely at stool after the bowel has been emptied has been pointed out as a competent producing cause.

**Clinical Features.**—In the beginning there is merely an exaggeration of the normal protrusion of mucous membrane accompanying the final effort of emptying the bowel. The extent of the protrusion gradually increases until there is a conical projection, varying in length from 2 to 4 or 5 inches. At first the mucous membrane is bright red, later becoming bluish from

Fig. 198.—Prolapse of Rectum.

venous congestion resulting from the grasp of the sphincter at the base. The lumen of the bowel is evident and the mucous membrane is continuous at the base with the skin. At first reduction is easy but as the size of the projection increases there is greater difficulty in replacing it. In cases where it remains down for a long time there may be ulceration of the surface and even sloughing of a part or the whole of the protrusion. In aggravated cases the sphincter is dilated and without tone.

**Diagnosis.**—The condition is usually diagnosed without difficulty. A rectal prolapse is distinguished from a protruding intussusception by the fact that the finger can be passed into a culdesac between the margin of the anus and the protruding mass. In the case of a polyp the finger can be passed completely around the mass. Rarely a nevus occurs at the anal margin and if the condition is kept in mind it is easily distinguished.

**Treatment.**—In children conservative measures are usually successful. It is well to remember that most cases of complete prolapse are the natural evolution of a neglected incomplete prolapse. Careful attention to the

improvement of the general health, the removal of all causes of straining, keeping the stools soft with mineral oil or other measures usually serve to cure the milder forms of prolapse. Cold douches and astringent enemata are often of value. When the prolapse has occurred it must be reduced. The child is placed face downward on the lap (sometimes anesthesia is necessary); the mass is covered with a compress wrung out of cold water and the surgeon gently endeavors to decrease its size and then it is reduced, beginning with the apex. After reduction a conical pad with the apex at the anus held in place by a T-binder serves to maintain the prolapse in position. If possible the child evacuates the bowel while lying down. An adhesive strap with its posterior edge in front of the anus holding together the buttocks is often efficacious. It may be left on for several days as the constant removal of adhesive is irritating to the skin. When simpler measures fail, injection of various substances, notably alcohol, have been advised. The best of the simpler operations is the linear cauterization in vertical lines ½ inch apart throughout the entire circumference of the protrusion. The mass is then replaced and the mucous surfaces kept apart by means of a strip of vaselin gauze. The rectopexy of Ekehorn, in which a suture is passed through the posterior rectal wall and about the lower sacrum, is said to give good results. Ombredanne relies on a silver wire inserted subcutaneously about the anal orifice and removed after from six weeks to three months. There is rarely, if ever, place in children for the more complicated operations necessary in adults. As a matter of fact, a careful attention to detail will serve to cure the great majority of cases with only simple means. A few will require linear cauterization. Very rarely alcohol injection, rectopexy or silver wire about the anus is indicated. Amputation of the protruding mass is never indicated in children. It is dangerous in the aggravated cases as the peritoneal cavity may be invaded, and always unnecessary in the milder forms.

## PERIANAL AND ISCHIORECTAL ABSCESS

These conditions differ little if at all from the same conditions in adults save in the fact that resulting fistula is very rare. Suppuration may be subcutaneous, perianal or in the ischiorectal fossa. The former is more common. There is a tender red swelling at the side of the anus outside the external sphincter. A small incision and packing of the cavity is all that is necessary. An ischiorectal abscess results from an infection from within the rectum. In this instance the abscess is larger and may bulge into the rectum. A radial or crucial incision will suffice to produce a cure. Very rarely an ischiorectal abscess may follow a pelvic cellulitis. A residual pelvic abscess resulting from peritonitis may perforate into the rectum.

## FISTULA IN ANO

Fistula in ano is rare in children but when it does occur the tract is laid open and packed so as to heal from the bottom. There is a form of incomplete external fistula resulting from chronic subcutaneous abscesses in the region of the anus which is not uncommon. This may be tuberculous in origin. The treatment consists in excision with immediate suture.

## HEMORRHOIDS

Hemorrhoids are rare in children and usually of the external variety. Chronic constipation is the common cause and with the relief of this condition they usually disappear. Operation is very rarely indicated.

### REFERENCE

Fitchet, Seth M. Imperforate Anus—The Surgical Treatment of Cases of Maldevelopment of the Terminal Bowel and of Anus, Boston M. & S. J., 1926, 195:25.

# CHAPTER XXIII

## SURGERY OF THE GENITO-URINARY ORGANS

### GENERAL CONSIDERATIONS

The child is subject to most of the maladies of the genito-urinary system seen in adult life. Painful and difficult micturition, enuresis, increased frequency, hematuria, pyuria, pain and swelling in one or both kidney regions or in the region of the bladder are the symptoms and signs which singly, or in combination, manifest derangements in the urinary tract. The frequency of congenital malformations in the ureters and bladder is striking.

**Cystoscopy.**—Since the development of the small calibered cystoscope all the scientific methods employed in the urological examination of the adult have become applicable to children. Cystoscopy, when properly controlled, is practicable in early life; in infancy in girls and in early childhood in boys. The cystoscopic examination of any young child involves certain immediate risks and in the male there is the further possibility of sufficient injury to result in lasting stricture of the urethra. Therefore the procedure should be reserved for those cases where such investigations are definitely indicated and after all other methods of differential diagnosis have failed. An extensive cystoscopic examination is not justified unless an accurate diagnosis may result in a change of treatment or in the undertaking of an operation. The total renal function should be known before carrying out such an examination.

**Catheterization.**—The value of catheterization is often overlooked. This measure gives information as to the character of the uncontaminated bladder urine. The capacity of the bladder, as well as the amount of residual urine, if present, is determined. A ureteral catheter is employed in catheterizing infants. The evidence obtained by the Roentgen ray may be valuable. After the injection of radiopaque fluid a cystogram may be made showing the bladder outline, and revealing diverticula or reflux into the ureters, with whatever degree of dilatation exists.

**Urinary Obstruction.**—Obstruction to the urinary outflow occurs quite frequently in childhood. Usually the result of congenital anomalies, it may be caused by intrinsic lesions of the ureter or bladder, by pressure from without and very rarely from an extreme degree of phimosis. The intrinsic lesions occur most commonly at the junction of the ureter and pelvis of the kidney, the vesical orifice of the ureter or in the region of the veru-

montanum. Anomalous renal vessels, either artery or vein, reduplication of the pelvis and ureter, or diverticulum of the bladder may cause pressure from without. Aberrant vessels are recognized as a not infrequent cause of intermittent hydronephrosis in adults. In such cases there is an extra vessel to the lower pole of the kidney, either an artery or vein or both, usually a vein. The vessel presses on the anterior surface of the ureter and results in obstruction to the flow of urine. Whenever pressure sufficient to cause obstruction exists, symptoms result. Symptoms are usually not noted in early life as the amount of pressure depends almost entirely on the position of the kidney. Occasionally such vessels do cause intermittent hydronephrosis or recurring pyelitis in children. When any of these types of obstruction exists it is important that the obstruction be relieved at once, to prevent extensive destruction of renal tissue. Complete urological investigation is indicated whenever there is a suggestion of obstruction and in all cases with persistent or recurring pyuria.

Chronic retention of urine due to obstruction at the neck of the bladder may be diagnosed with the aid of a catheter. This condition is particularly amenable to surgical treatment and failure of recognition, in the early stages, results in destruction of kidney tissue and infection. It is, of course, important to consider the possibility of the presence of spina bifida occulta whenever there is chronic retention. This condition may usually be diagnosed with the aid of the Roentgen ray. Urinary stasis is invariably accompanied by infection, and the persistence of pyuria after intensive treatment over a reasonable period is a definite indication for urological examination. When operation is undertaken it is important to bear in mind that strictures may be bilateral and to ascertain the condition of the opposite kidney before proceeding to nephrectomy.

Hydronephrosis may result from obstruction at any one of the sites mentioned. Obstruction in the region of the verumontanum frequently results in a bilateral hydronephrosis. A bilateral stricture of the ureter above the bladder would result in a similar condition. This latter condition occurs as frequently in girls as in boys. As a result of back pressure there is destruction of the kidney parenchyma with secondary infection. The ureters are enlarged to many times their normal size, are tortuous in outline and may have every appearance of small intestine. There is little field for surgery in the bilateral type.

Of more interest to the surgeon are the cases in which there is a unilateral lesion. Obstruction at the pelvic outlet or lower down in the ureter is the usual cause. The condition may be present at birth or may develop subsequently. It may be persistent and progressive or there may be periods of remission when the tumor apparently decreases in size. Diagnosis usually depends upon the presence of a cystic tumor. This tumor may not be tense

and may not be identified as sacculated fluid. Hydronephrosis may be mistaken for an ovarian cyst, or, in older children, tuberculous peritonitis. If secondary infection has occurred the urine will show pus.

While the congenital hydronephrosis resulting from the lesions mentioned is not uncommon, the acquired form is so rare as to be exceptional.

FIG. 199.—RIGHT HYDRONEPHROSIS IN INFANT TWO MONTHS OLD.

Roentgenogram after opaque enema. Note displacement of colon. Right transperitoneal nephrectomy. Uneventful convalescence.

It does occur, however, and may be either bilateral or unilateral. Pressure upon the ureter by ovarian cyst, anterior spina bifida or other tumor, impaction of a stone in the ureter or obliteration of the ureter from other causes may result in dilatation of the ureter and of the pelvis of the kidney.

*Treatment.*—The destruction of kidney tissue has usually been so great that nephrectomy is indicated. The transperitoneal approach through a pararectal incision is the method of choice. The operation is technically less difficult and the condition of the opposite kidney may be ascertained by palpation.

## PHIMOSIS

Phimosis is the commonest malformation of the genital organs. In this condition the orifice in the prepuce is so small that retraction over the glans is impossible or very difficult. There are various degrees of the condition from a pin-point orifice to those where the foreskin can be retracted but when retracted is so tight as to impede the circulation. In addition there may be imperfect separation of the prepuce and the glans. In the newborn there is a physiological phimosis which continues for a longer or shorter time. The inner leaf of the foreskin is adherent to the glans. This adherence may be readily separated with an instrument or by retraction of the foreskin. Usually included in the general term phimosis is the condition in which the prepuce is simply redundant without any actual contraction of the preputial orifice. Phimosis may be congenital or acquired. While the acquired form is relatively uncommon in childhood, it may occur as a result of injury of a poorly executed circumcision or of a chronic inflammatory process, usually caused by repeated attacks of balanitis.

In congenital phimosis the prepuce, in addition to having an unduly small orifice, is usually redundant and those slight adhesions, which at birth normally exist between the prepuce and glans, persist to a greater or less extent. In many instances the frenum is short, more rarely the prepuce is short and is tightly applied to the glans to which it is intimately adherent. In the sulcus behind the corona there may be an accumulation of smegma and epithelial débris which forms a white, puttylike mass or is aggregated into small concretions.

The chief difficulty which presents itself in childhood is interference with micturition, obstruction of the stream and in those cases with a redundant foreskin the urine may distend the preputial pouch. In the extreme forms dilatation of the bladder and even of the ureters and renal pelvis with resulting hydronephrosis has been observed. The urine retained in the foreskin decomposes with a resulting inflammation of the parts—balanitis. The straining necessary to overcome the obstruction may determine a hernia or aggravate a tendency to prolapse of the rectum. As a result of the local irritation of balanitis various reflex disturbances have been ascribed to phimosis, particularly incontinence of urine, nocturnal enuresis, nervous irritability and sexual irritation. Convulsions, epilepsy

and various other nerve disturbances have also been attributed to this cause, probably with little reason.

The condition is usually apparent on inspection and the degree is demonstrated by an attempt at retraction of the prepuce. In many instances all that is necessary is to pull back the foreskin and remove any collection of smegma. Where there is imperfect separation of the prepuce and glans they should be separated and the parts lubricated until healing has occurred. Forcible dilatation is only permissible when the orifice is easily dilatable without the production of fissures. In those patients in whom the preputial orifice is narrow enough to cause any difficulty in retraction or when the prepuce is redundant circumcision is indicated. Recurring attacks of balanitis or the presence of reflex conditions which might be the result of irritation of the glans are also indications for operation. The routine performance of circumcision when there are no anatomical indications is to be deprecated.

## CIRCUMCISION

The object of circumcision is to remove the excess of prepuce in such a manner as to leave a covering for the corona glandis without any narrowing of the orifice. There are many methods described. It is well to remember that while circumcision is considered a simple operation and one to be carried out by any practitioner, there are not infrequent complications, some of which may be very serious. Where the orifice is narrow but the prepuce is not abnormally redundant, it is often sufficient to do a dorsal slit, that is, to slit the skin longitudinally along the dorsum. A director is inserted between the prepuce and the glans (great care being exercised that the director is not introduced into the urethra) and one blade of a fine Mayo scissors passed along the director. The incision should extend a short distance beyond the corona. The skin and mucous membrane may be united with a few sutures of fine plain catgut. This method is usually indicated in the presence of inflammation and edema, otherwise it is better to carry out the regular operation of circumcision.

The operation may be carried out in infants without anesthesia, but, in general, anesthesia is desirable and the anesthesia of choice is ether. The parts are carefully cleansed with soap and water followed by alcohol. The orifice is dilated, if necessary, the prepuce is retracted and all adhesions separated with as little trauma as possible, the glans cleansed of all adhering smegma, and finally the parts sponged off with alcohol. The redundant prepuce is drawn forward, exerting equal tension on the skin and mucous membrane. It is then seized with a pair of thin-bladed forceps applied obliquely from above downward and forward just in front of the

glans. The forceps are loosely clamped or held, the position of the glans is confirmed and the excess of prepuce is cut off in front of the forceps with a sharp knife. On release of the forceps the skin retracts, leaving the mucous membrane to cover the glans. Bleeding vessels between the skin and mucous membrane are ligated at the skin edge. The mucous membrane is lifted from the dorsum of the glans, a straight cut made almost to the corona and the redundant portion is trimmed off around the circumference of the corona, care being taken to leave sufficient mucous membrane to cover the edge of the corona. All bleeding vessels are carefully ligated and the skin and mucous membrane are united with interrupted sutures of fine chromic catgut. After suturing is completed the entire circumference of the wound is again inspected for bleeding. All manner of dressings have been advised: Dry, with various powders such as boric acid, bismuth subcarbonate or thymol iodid; boric ointment without any other dressing than an apron of gauze. The best dressing is probably, however, one which is made up of a rolled piece of gauze (1 inch gauze packing is suitable), thoroughly saturated with vaselin and held by four sutures tied at equidistant points and then tied about the rolled gauze fixing it in place. In addition a flat gauze pad is covered with vaselin, fixed to the abdomen with adhesive and allowed to hang down over the penis like a small apron. The original rolled gauze dressing remains until the sutures separate.

**Postoperative Complications.**—*Hemorrhage.*—Careful attention to detail at the time of operation will usually prevent this complication. Should it arise, however, it is probably better to remove the sutures, clean out the clot, secure the bleeding point and resuture the wound. In slight degrees of bleeding a solution of adrenalin 1 : 1,000 or thromboplastin may be tried.

As a result of infection or faulty operation there may be cicatricial contraction of the preputial orifice. Such a condition is remedied by a second operation.

*Congenital Stenosis of the Meatus.*—This condition occurs in varying degrees and is not infrequent. In the lesser degrees dilatation is sufficient. When the stenosis is such as to materially interfere with the passage of urine, retention and even dilated ureters and hydronephrosis may result. In these unusual cases simple incision and dilatation may not be sufficient.

One method advised is to pass a non-absorbable suture through the meatus and out through the floor of the urethra ⅛ inch back of the meatus leaving the suture untied. The meatus is enlarged ventrally almost to the suture which is then tied around the bridge of tissue and allowed to cut its way out. Subsequently the meatus should be dilated with a catheter or glass rod once or twice a week for a month or more.

*Ulcer of the Meatus.*—There may develop an area of excoriation about the meatus either immediately following circumcision or at some later date. From this area there is a seropurulent discharge which causes the edges of the meatus to adhere occasionally to such a degree as to result in acute retention. In any event there is pain on micturition. The lack of protection from the prepuce and possibly decomposition of the urine which tends to remain in the meatal opening is the cause of this condition. The treatment is to keep the area as dry as possible and to protect it by the application of vaselin. Occasionally it may be necessary to enlarge the opening by a small incision above and below.

*Paraphimosis.*—In this condition a somewhat tight prepuce has been retracted behind the corona with a resulting constriction interfering with the circulation in the parts distal to the constricting ring. If this is unrelieved ulceration and sloughing may occur.

Treatment.—The glans must be reduced through the constricting ring. When there is a tendency to recurrence or when reduction is impossible the constricting ring must be divided on the dorsum with a sharp scalpel. After the parts have returned to normal a regular circumcision may be carried out. It is unwise however, to do this operation while the parts are inflamed and distorted by edema.

## ADHESION OF THE CLITORIS AND ITS PREPUCE

In girls adhesion of the clitoris and its prepuce with retention of smegma may result in local irritation. It is most unlikely that this condition is the cause of the various nervous phenomena which have at times been ascribed to it. If adhesions are evident and there is local irritation the adhesions may be separated with a grooved dissector. Amputation of the prepuce of the clitoris is never indicated.

## HYPOSPADIAS

Hypospadias is a congenital malformation in which as a result of imperfect fusion of the margins of the urogenital sinus the floor of the urethra is deficient to a greater or less extent. The arrest in development may take place at any stage; when closure has reached the perineoscrotal region, somewhere in the penile portion or, most frequently, underneath the glans, where the urethral canal often ends in a minute hole or slit. Perineoscrotal hypospadias is the most severe and, fortunately, the least frequent form. In this type the scrotum is cleft and the urethra opens in the perineum. The penis is poorly developed, usually bent vertically and of no physiological use in its deformed condition. In such cases determi-

nation of sex may be impossible, particularly if the testicles have not descended.

Less severe, and also more frequent, is the penile type in which there is an opening in the urethra on the under surface of the body of the penis. In appearance this opening closely resembles a traumatic urethral fistula. The condition of the urethral canal in front of the opening varies greatly. The meatus and urethra may be normal, the canal may be normal and the meatus closed or the meatus may be present with a urethra which ends

Fig. 200.—Penile Hypospadias.

blindly. On either side of the urethra or median groove there are bands of dense fibrous tissue which cause the penis to be bent sharply with the concavity facing downwards. This fact is of the greatest importance in the surgical treatment.

Balanic hypospadias, the slightest degree, is fortunately by far the most frequently observed. In this type the urethra opens at the base of the glans, the frenum is absent as is also the prepuce on the inferior surface although it is redundant on the upper surface of the glans. The abnormal orifice is often pin point in size. The shape of the glans varies and there may be a more or less deep groove continued from the abnormal opening

to the site of the normal meatus with a urethral canal which ends blindly in front of the abnormal opening.

**Clinical Features.**—The amount of discomfort caused by this malformation varies very much according to the position of the abnormal opening. In the perineoscrotal and penile varieties urination is difficult and the genital function is materially affected. The various degrees of balanic hypospadias give rise to much less discomfort. However, if the orifice is greatly narrowed all the consequence of urethral stricture may be observed, dilatation of the bladder and ureters with infection which may eventuate in pyonephrosis. Reference has been made to hypospadias in the male only. The occurrence in the female is so rare as to render description unnecessary.

**Treatment.**—In the slighter degrees of the balanic type where the orifice is not too small it is probably better not to consider operation advisable at any time as the disability is so slight as to be negligible. While the operation to correct this slight deformity may appear simple it often does not prove so and there are many failures. A narrowed orifice, of course, necessitates incision. In the more severe degrees of hypospadias operation is imperative. It should, however, not be undertaken until after the sixth year, preferably the ninth to the eleventh. At this time the coöperation of the child may be secured and the parts are larger. Many ingenious operations have been devised but their description would be out of place in this volume and those interested are referred to special articles on the subject.

## EXSTROPHY OF THE BLADDER

This is a rare condition, occurring about once in fifty thousand births, most frequently in males. A hiatus resulting from failure of the ventral laminæ of the embryo to meet in the midline causes the anterior half of the bladder, together with a portion of the anterior abdominal wall and the symphysis pubis, to be lacking. The posterior wall being unsupported pushes forward and projects in the midline below the navel. The extent of the malformation varies in degree and epispadias is usually associated. The bladder wall appears as a red, spongy area which may show excoriation from contact with the clothing. In the lower part of this area the ureteral openings may be made out and in the male, at the lower margin, may usually be found a rudimentary penis in which the urethra is represented by an open gutter on the dorsum. Just behind the glans penis the urine trickles out and by tracing its point of appearance the openings of the ureters may be discovered. As a result of the malformation bilateral inguinal hernia often complicates the condition and this is practically the only condition in which a direct inguinal hernia occurs in childhood. Spina

bifida, cleft lip and palate, malformations of the rectum and anus and various other congenital malformations are often associated. There is no control of the urine, the skin becomes red and excoriated and decomposition of the urine causes a most offensive odor. While at least two-thirds of all persons afflicted with this malformation are dead by their twentieth year, often from ascending infection, a certain number not only live but follow laborious occupations.

**Treatment.**—There is no condition in which greater ingenuity has been employed to devise a satisfactory method of alleviating a distressing deformity. While many efforts have been made to complete a bladder by means of flaps the absence of control and the necessity of using hair-bearing skin in the flaps has resulted in the abandonment of all such methods. The operations which offer the greatest degree of comfort are those in which, by various methods, the ureters are transplanted into the pelvic colon, into the rectum or into an isolated portion of the intestine. In one instance in which I carried out the operation advised by Peters—extraperitoneal implantation of the ureters into the rectum—the child has acquired control to the extent of retaining urine for as long as six hours in the rectum. He goes to school and leads a relatively normal existence. Undoubtedly operation is indicated in every instance where there is complete control of the rectal sphincter and probably the intraperitoneal implantation of the ureters into the pelvic colon is the operation of choice. In infancy the operative mortality is very high and the procedure should not be undertaken usually until after the second year. From two to five years is the most favorable period. After ten years there is greater liability to dilatation of the ureters which makes operation inadvisable. Immediately after operation it is well to remember

FIG. 201.—EXSTROPHY OF BLADDER IN AN INFANT FIVE WEEKS OLD.

that the patient is receiving what amounts to an enteroclysis of urine, and symptoms of uremia frequently manifest themselves. It is advisable to leave a tube in the rectum for a number of days to facilitate the drainage of urine and to carry out frequent warm saline irrigations of the bowel. After the urine has been diverted into the colon the bladder wall may be dissected out and hernia or other associated malformations corrected. If the bladder wall is not removed its surface sometimes becomes so changed as to resemble skin.

## EPISPADIAS

The description of epispadias naturally follows that of exstrophy of the bladder because the malformation is of the same kind. A portion or all of the roof of the ureter is absent and the urethral canal is represented by a furrow of mucous membrane on the dorsum of the penis in the male, or as an open trough lined with mucous membrane, leading from the bladder into the vestibule in the female. The penis is stunted, curved on itself with the concavity upwards and fixed in this position by strong fibrous bands. The prepuce is usually redundant and hangs in the form of an apron of skin from the glans. The malformation varies in degree: (1) Involving only the glans; (2) penile; (3) spongioglandular, involving the glans and a portion of the spongy body; (4) complete, involving the entire urethral canal from the meatus to the neck of the bladder.

In those cases in which the entire length of the penis is involved there is always a deficiency in the neck of the bladder and its sphincter resulting in incontinence which may be partial or complete, more often the latter. When, as usually happens, the condition is associated with exstrophy of the bladder the treatment is a part of that of the bladder malformation and is usually carried out after the ureters have been transplanted and at a somewhat later age. When the condition occurs by itself treatment is begun at the same age period as is advantageous in the case of hypospadias, after the sixth year. The operative procedures are complicated and consist of many stages. Those interested are referred to special articles on the subject.

## PYELITIS

Pyelitis, so-called, infection of the upper part of the urinary tract, is the most frequent of the various inflammatory affections of this region.

A systematic account of this disease has been appropriately given in another volume. From the surgical standpoint the importance of the condition consists in:

1. Its differentiation from abdominal disease in which operation is indicated.

2. The determination and correction of a complicating factor such as congenital stricture of the ureter or renal or ureteral calculus.

3. The recognition of a primary focus of infection, particularly in the staphylococcal form.

In general the onset of pyelitis is sudden and the local evidence of the disease is not commensurate with the general reaction. This is particularly true at the period of life when pyelitis is most frequent, namely, the first two years. In pyelitis of the newborn, boys are more often affected, and subsequent to this period up to the second year, girls generally predominate. After the second year, girls are only slightly more frequently affected than boys.

The infection is usually caused by a member of the colon group, less frequently by the staphylococcus or streptococcus. The route of infection has not been determined and probably varies. One theory explains the predominance in girls on the basis of an ascending infection due to the short female urethra. Direct extension through the lymphatics from the overlying colon is another possible route. Probably most frequently, infection is carried by the blood stream. Staphylococcal or streptococcal lesions involving the cortex are probably hematogenous. The exact pathology of pyelitis in infancy has never been definitely established. It is probable that suppurative nephritis is the disease most frequently causing pyuria in infancy and that primary inflammation of the lining of the pelvis of the kidney rarely occurs in the absence of obstruction. The initial kidney damage may be due to a streptococcus or staphylococcus infection and the colon bacillus may be really a secondary invader.

In the younger children there is usually little local evidence of the disease. The diagnosis is often only made as a result of urinalysis. The child is irritable and uncomfortable generally, the temperature is high, 103°-105°, with often a considerable leukocytosis. There are usually wide excursions of temperature and, at first, when the temperature is down, the patient appears little if at all ill, though frequently a curious waxen pallor is manifested. The urine is acid, contains pus and often shows a faint trace of albumin. It must be remembered that pus may not appear in the urine for several days after the onset, may not be present in each specimen, and may disappear, to appear again. Even in the absence of pus a large number of colon bacilli may be demonstrated. Gastro-intestinal disturbance, nausea and vomiting and diarrhea may precede or accompany the attack. Abdominal tenderness and muscular rigidity are unusual

but may occur, particularly in those cases where there is wide involvement of the renal parenchyma.

**Diagnosis.**—The absence of abdominal rigidity and the pyuria are the most important aids in distinguishing the condition from abdominal affections. It must be remembered, however, that pus in the urine not infrequently occurs during appendicitis. Furthermore, inflammation in an appendix located in the pelvis and surrounded by coils of small intestine is often not characterized by abdominal rigidity. In my experience appendicitis is more often mistaken for pyelitis than the reverse. While it is not necessary always to obtain catheterized specimens of urine, care must be taken in collecting the specimen to avoid contamination from the vulva or prepuce. More than two leukocytes to a low power field in the case of boys and more than five or six in the case of girls may be regarded as abnormal, particularly if the cells appear in clumps.

**Prognosis.**—In the ordinary case of pyelitis the prognosis is almost uniformly good. The condition frequently occurs as a concomitant of respiratory infections and in such instances its seriousness is increased. When pyelitis persists for long periods in spite of treatment serious consideration must be given to the possibility of complicating factors, such as calculus, ureteral or renal, and congenital anomalies. If the condition has shown no evidence of clearing up after intensive treatment for three or four weeks, urological examination is indicated and may be carried out in detail with relative safety in infancy in the case of females and in early childhood in boys. In all cases, and particularly where streptococci or staphylococci are demonstrated in the urine, the possibility of a primary focus must be kept in mind.

**Treatment.**—The treatment is essentially medical and consists in increasing the fluid intake and in the exhibition of alkalies, usually sodium citrate and sodium bicarbonate in equal parts in large doses. The reaction of the urine must be watched with litmus paper. Proper regulation of the diet is of considerable importance. Regular evacuation of the bowels must be obtained and colon irrigations may be indicated. After the urine has been rendered alkaline for some days it is often desirable to change to urotropin with acid sodium phosphate for a time. Even after symptoms have disappeared and pus is no longer found the patient cannot be considered cured until two negative urine cultures have been obtained. Lavage of the pelvis is rarely if ever indicated in uncomplicated cases. Any cause of urinary stasis must, of course, receive appropriate treatment. Surgical operation with a view to decapsulation or other procedure has been advised at times. In such cases it should be remembered that the process is almost certainly bilateral and operation reserved for those exceptional instances where there is evidence of perinephritic abscess.

## URINARY LITHIASIS

Stones in the urinary tract are more frequent in infants and young children than is generally supposed. After an attack of supposed intestinal colic a small stone may be passed. The condition is more frequent in children who live in regions where stone is endemic. The etiology is not determined but infection is always associated and may be one of the factors. It is more frequently observed in boys than in girls, due to the anatomical characteristics of the female urethra through which stones are more easily passed. Calculi are formed, with few exceptions, in the kidney and pass thence to other parts of the urinary tract. Occasionally a stone is formed in the bladder by the deposition of urinary salts on a foreign body. There are several varieties and while some are composed of one salt the greater number are made of alternate layers of two or more. Calcium oxalate, uric acid and its salts and phosphates are the usual constituents, named in the order of frequency.

The majority of urinary stones in children seem to pass rather easily through the ureter and only a small number remain in the kidney. Impaction, however, may occur in a calyx, in the pelvis of the kidney, in the ureter, in the urethra or the stone may remain in the bladder. Approximately 70 per cent are found in the bladder or urethra.

**Pathology.**—If the stone in its passage from the kidney to the bladder becomes impacted at any point there is obstruction with a resulting hydronephrosis. Whether the stone causes obstruction or not there is always infection with a resulting pyelitis and eventually pyonephrosis. The stone may be silent for years but always, sooner or later, makes its presence felt.

**Clinical Features.**—The older the child the more closely is the clinical picture in the adult approximated. In infants, sudden prolonged abdominal pain without diarrhea and with or without hematuria when there has been no previous gastro-intestinal upset and without evidence of peritoneal irritation may suggest urinary calculus. Sudden complete relief adds weight to the suspicion. The ureter of the infant is capable of great distention and obstruction occurs relatively seldom.

In older children while the stone remains in the kidney, there may be pain in this region, radiating to the front and toward the genitals. Typical attacks of renal colic may occur. Micturition is frequent and may be painful and hematuria and pyuria may be present. The kidney may be enlarged and tender. In its passage along the ureter similar characteristic symptoms are present. Rarely anuria from blocking of both ureters by stones is observed.

After the stone reaches the bladder it may be voided without difficulty

and it is surprising what large stones may be passed. A stone may become impacted in the urethra, either in the perineum, body of the penis, or just behind the meatus. Local pain usually results followed by urinary retention but the condition may be first discovered on the attempt to pass a catheter. If the condition is unrelieved, extravasation of urine may occur. If the stone remains in the bladder there is a tendency for it to increase in size by the deposition of salts on its surface. Even here there may be few symptoms. Usually, however, there is irritability, increased frequency of micturition and pain at the end of the act. The child cries and may be afraid to pass water. There may be a sudden stoppage in the flow from blocking by the stone. With the inevitable resulting cystitis the condition becomes aggravated and distressing. Hematuria is said to occur seldom and this is probably true of gross blood but if a careful urinalysis could be made there would probably be many cases in which microscopic blood would be found. Pus is practically always present and when the stone has remained for a long time in the bladder the reaction of the urine may be alkaline and the urine acquire a foul odor.

**Diagnosis.**—In the history one should inquire into the degree of pain, its situation and radiation and any peculiarities in urination and as to the condition of the urine. As far as possible the whole urinary tract should be palpated. A rectal examination should be made as occasionally a stone may be felt in the bladder or ureter by this method. Roentgenography should, of course, be employed but it must be remembered that certain stones, notably the pure uric acid stone, may not be distinguished by this means. The urine must of course be examined for crystals and abnormal constituents. Finally cystoscopic examination and if indicated ureteral catheterization should be carried out.

**Treatment.**—Where a small renal calculus is discovered in the pelvis of the kidney opportunity should be given for its passage. Fluids should be forced and alkaline drinks given. The situation of the stone may be watched with the aid of the Roentgen ray. When the stone does not progress or when it is causing damage to the kidney early surgical removal should be practiced. The methods of operation used in adults are equally applicable in children. When the stone is in the bladder it may, if the patient be a girl, be extracted through the urethra after dilatation. In the case of large stones in girls, and in the case of most stones in boys, a suprapubic cystotomy is probably the best method, though litholapaxy may, in certain instances, be indicated. Usually, unless the urine is very foul, immediate closure of the bladder is practiced after cystotomy. Bilateral lithiasis, when the stones are small and situated in the cortex of the kidney, should be treated expectantly. When the stone is impacted in the urethra and gentle attempts to express it have failed, an effort to intro-

duce forceps and crush it may be tried after incision of the meatus. Occasionally an incision in the urethra is necessary. Where there is extravasation of urine multiple incisions are of course indicated in the affected tissues.

## CONGENITAL ANOMALIES OF THE KIDNEY

The kidney sometimes fails to attain its normal position and lies nearer the midline, or lower in the abdominal cavity. It may be on a level with the sacral promontory or even in the cavity of the pelvis. The kidney acquires its blood supply only after it attains its final position and congenital displacement is distinguished from the movable or floating kidney by the low origin of the renal vessels.

Fetal lobulation may persist but is of no clinical significance. The two kidneys may lie near the midline and their lower ends be fused. This condition is called horseshoe kidney. The connection may involve the capsule only but is usually composed of renal parenchyma. The ureters cross the bridge of tissue and one or the other may be so kinked as to produce obstruction with a resulting hydronephrosis. The condition must be kept in mind in differentiating obscure abdominal tumors, and a palpable mass in the midline is suggestive of horseshoe kidney. One kidney may be imperfectly developed or absent. This anomaly may be associated with an undescended testicle on the same side. The two kidneys may be fused, one lying in its normal situation, the other immediately below and fused with the lower pole of the normally situated kidney. The ureter from the lower kidney passes across the midline to enter the bladder from the opposite side. The consideration of these various anomalies is of importance whenever the question of nephrectomy comes up. One of the great advantages of the transperitoneal operation is the fact that opportunity is afforded for investigation of the situation and condition of the opposite kidney.

## RENAL CYSTS

**Polycystic Kidney.**—Polycystic disease is almost invariably bilateral and is not amenable to surgical treatment. At the time of examination one kidney may be much more involved than the other. In some instances it has been necessary to empty the cysts before delivery of the child was possible. Other cases are noted in newborn infants. In later childhood and early adult life the condition rarely manifests itself. It is in early middle life that other cases come to the surgeon for tumor, hematuria or pyuria. In spite of the great destruction of the kidney tissue which has been replaced by cysts, adult life and middle age may be attained with few or no symptoms. The condition is one in which the kidneys are the site

of multiple cysts which have developed in the renal parenchyma. Cysts of the other organs, notably the liver, are not infrequently associated. Females are most often affected. Congenital anomalies, such as harelip and hypospadias, may occur in conjunction.

The pathogenesis of the disease remains uncertain. Virchow advanced the theory that the disease originates because of obstruction of the tubules as a result of chronic interstitial inflammation. Another theory is that of new growth. A third, and probably the best supported view, is that the cysts result from developmental malformation and are therefore congenital.

*Diagnosis.*—Single or bilateral nodular tumors in the kidney region suggest the condition but it is rare indeed that the diagnosis is made definitely in an infant before exploratory operation. Surgical treatment is not indicated.

**Solitary Cyst of the Kidney.**—Large, solitary cysts of the kidney are more rarely seen than is polycystic disease. The condition is usually unilateral. It results either from congenital malformation or from obstruction. While a diagnosis of tumor in the kidney region may be made, the true pathology is usually discovered only at operation.

*Treatment.*—If possible the cyst is enucleated. If, however, it is firmly adherent, resection of the cyst with a portion of the kidney is indicated. In very large cysts nephrectomy may be necessary.

## TUBERCULOSIS OF THE KIDNEY

While tuberculosis of the kidney is relatively rare in young children the proportion of cases gradually increases with age. While a focus of tuberculous infection must exist somewhere in the body, as infection of the kidney is almost invariably by the blood stream, the patient may appear to have no other evidence of the disease. Renal tuberculosis may occur as part of a generalized process but more frequently it exists without obvious other lesions. The condition occurs more frequently in girls than in boys, a fact which has been explained on the basis of the greater frequency of so-called pyelitis in girls. Both kidneys are involved more frequently than in adults. As in the male adult, there occasionally occurs in boys tuberculosis of the epididymis extending to the bladder and eventually involving the kidney.

**Pathology.**—The pathology is the same as in the adult and the process is usually of the caseating cavernous type. Individual nodules may rupture into the pelvis which, with the ureter and bladder, becomes involved and secondary infection with pyogenic organisms is added. If the opening of the pelvis into the ureter becomes blocked there is an accumulation of pus

and débris, destruction of the parenchyma proceeds and a tuberculous pyonephrosis results.

**Symptoms.**—Frequent and painful urination or even incontinence of urine is usually the earliest symptom. Macroscopic hematuria, while not common, occurs as an early symptom of renal tuberculosis in children more frequently than of renal calculus. Chronic pyuria without other symptoms may be the only manifestation. There is often an obvious decline in health and a slight rise of temperature in the evening. Pain in the region of the kidney together with increase in size are late in appearance.

**Diagnosis.**—Urinalysis shows pus and possibly red blood-cells. The presence of tubercle bacilli in the urine is of course positive evidence taken in conjunction with local signs. Their absence, however, does not exclude the disease and in cases under suspicion animal inoculation is indicated. In the late cases the kidney may be made out to be large and tender. The Roentgen ray may give evidence of importance as not infrequently areas of calcification will be shown in the affected kidney. The absence of such shadow is not proof, however, that renal tuberculosis is absent. Cystoscopic examination, with catheterization of the ureters, reveals the condition of the bladder and that of the opposite kidney. To be distinguished are chronic pyelonephritis, tumor of the kidney and cystitis.

**Prognosis.**—The prognosis is not so good as in adults, but where a single kidney is involved its removal may be expected to give good results. Even after the ureter and bladder have been affected the removal of the involved kidney may result in disappearance of the disease. Without operation there is almost inevitable tendency to complete destruction of the organ with a subsequent generalization of the disease.

**Treatment.**—Where one kidney only is involved, nephrectomy is indicated at once. Even in involvement of both kidneys if the process is unequally distributed and one organ is only slightly affected life may be prolonged by the removal of the more damaged organ. Operation is contra-indicated where there is generalized disease or where both kidneys are severely damaged. When diagnosis is certain and when it has been possible definitely to ascertain the condition of the opposite kidney, nephrectomy through the lumbar route is the operation of choice. When, however, for any reason there is doubt of the situation and condition of the opposite organ, approach should be transperitoneal and opportunity afforded for palpation.

## TUMORS OF THE KIDNEY

The most important abdominal tumor in childhood is the tumor of the kidney. While benign tumors such as fibroma and adenoma have been recorded they are so rare as to be of relatively little importance.

The usual tumor is malignant and its pathology is of considerable interest. Variously named in the past, and commonly referred to as a mixed tumor, the term embryoma probably best characterizes the nature of the growth. Many views have been held as to the pathogenesis of these tumors and the problem is as perplexing as is that of the testicular tumor. The view that they are derived from embryonic tissue of the true kidney, this tissue persisting and becoming metamorphosed into cellular structures of various types, is probably the most tenable.

Histologically there is observed most frequently a cellular tumor with little stroma and fairly characteristic cells showing little differentiation. On the other hand, in slower growing tumors a very complex picture is presented in which various types of cells may be recognized, including smooth and striated muscle-fibers, elastic fibers, cartilage, bone and fatty tissue. The metastases are usually but not invariably of the undifferentiated cellular type. These tumors may assume large proportions and their growth is rapid. While the surface may be smooth it is often nodular. The consistence is usually firm except in areas where degeneration has occurred. Macroscopically they are either solid, opaque tumors or cystic, sometimes resembling congenital cystic kidney. There is usually a thick capsule. In most instances, normal kidney tissue remains in one or more areas. Cross section shows lobulation of the tumor tissue and there may be areas of hemorrhagic necrosis.

The sexes are equally affected and the greatest incidence is in the first five years of life. They may be congenital and instances are recorded in which the tumor was of sufficient size to obstruct labor. The embryoma is exceptional after fifteen years of age.

**Clinical Features.**—The clinical features of kidney tumor in childhood are in striking contrast to that in adult life. Almost invariably the tumor is the initial symptom, manifested as abdominal distention or in the actual discovery of the mass by the parents. Occasionally pallor, loss of weight, abdominal discomfort, diarrhea, constipation or vomiting are noted by the parents and cause them to consult a doctor. Hematuria is exceptional as an early symptom and rare in any stage of the disease. Pain, if present, is dull and due to pressure. One or two degrees of temperature are frequently noted. The growth of the tumor is at first slow but soon becomes rapid. At first the general health may be little interfered with, later there are associated with the rapidly growing tumor the signs of malignancy, anemia, emaciation and general weakness. There may be obvious signs of intra-abdominal pressure. The course of the disease is rapid and death usually occurs within a year and sometimes within a few months. The urine is often negative but may contain pus, albumin and casts. This type of tumor tends to recur locally, invading by direct extension the retro-

peritoneal gland-bearing tissue, but does not metastasize to the extent of other tumors of the kidney. When metastases do occur it is chiefly through the blood-vessels to the liver and lungs.

**Diagnosis.**—The insidious onset without premonitory symptoms makes early diagnosis exceptional. A tumor in the lumbar region of a child, especially if large and associated with anemia, is usually embryoma. Air injection of the colon is of help in differentiating left-sided kidney tumor from splenomegaly. Differentiation from tumors of the adrenal is only possible in the presence of metastases characteristic of the latter. While pyelography can be carried out in the child and often demonstrates characteristic deformities in the pelvis, it is in practice rarely indicated. When there are vague abdominal symptoms accompanied by unaccountable listlessness, even in the absence of any urinary symptoms the kidney regions should be carefully palpated and often only with the aid of anesthesia can a satisfactory examination be made. Tuberculosis of the kidney requires consideration but the kidney rarely reaches any considerable size from this disease in childhood. Furthermore, characteristic signs are present in the urine. Malignant growths of the retroperitoneal glands are usually centrally placed, while the kidney tumor is more lateral. Splenic enlargements due to leukemias, malaria or syphilis may be encountered. They are differentiated by the characteristic shape of the spleen, the relation to the descending colon as revealed by inflation and the

FIG. 202.—EMBRYONAL ADENOSARCOMA OF KIDNEY, CHILD TWO AND A HALF YEARS OLD.

investigation of the blood-picture. Hydronephrosis is characterized by a slower development, a cystic consistence, and frequently shows sudden variation in size. Ovarian tumors usually grow up from the pelvis and save in the very large cysts are more movable. A mesenteric cyst is usually differentiated by its mobility. Tumors of the liver are rare and the anterior border of the liver is usually quite distinctive. Tuberculous peritonitis may be difficult to differentiate. The polycystic type of kidney must always be considered.

**Prognosis.**—The outlook for recovery is poor. There are, to my knowledge, no instances of recovery without operation. The primary operative mortality with that due to recurrence is at least 95 per cent. The importance of early diagnosis is obvious as the growth apparently proceeds slowly for a time and then grows very rapidly. In considering operation, however, it is worthy of note that among the instances of permanent recovery there are cases which appeared far advanced and differed in no way, either clinically or pathologically, from other cases which went on to a fatal termination. Radiotherapy has, in certain instances, been of considerable palliative effect.

**Treatment.**—In spite of the poor prognosis the treatment is operative at the earliest possible moment. When the diagnosis is in doubt it is better to proceed at once with an exploratory operation. In the presence of anemia a preliminary transfusion is indicated. The approach should be through a vertical pararectal incision. Where the tumor has obviously extended beyond its capsule into the retroperitoneal tissue and its relations are such as to make its removal attended by great danger of immediate death, it seems to me unwise to proceed. The wound should be closed and radiotherapy instituted. Removal of the adjacent gland bearing area together with the kidney has been advised by some surgeons. In my opinion this is ill advised and adds an unwarrantable hazard without commensurate advantage. The removal of a large firm tumor, apparently confined within its capsule, is justified while a smaller tumor with obvious extension into the retroperitoneal gland-bearing tissue should be left.

## ADRENAL TUMORS

In recent years attention has been directed to certain tumors of the adrenal occurring in infancy and early childhood. These tumors may be divided into those arising from the medulla and those arising from the cortex. The adrenals are developed from a divided source, the cortical portion from the celomic epithelium, the medulla from the sympathetic system.

From the cortical remnants are developed hypernephromata, the most

frequent form of tumor in the kidney region in adult life. This form is rare in childhood, and while it may occur without such features, there is usually associated precocious maturity. Girls are more frequently affected and there is an overgrowth of hair on the face and pubes. In girls there is a tendency to the development of male characteristics at the expense of the female and in boys an intensification of male characteristics. The ma-

Fig. 203.—Metastases, Adrenal Neurocytoma, Infant Nine Months Old.

jority of patients are dull, though occasionally mental precocity has been noted. They all die before the sixteenth year. A similar association has been found in tumors of the pituitary and pineal glands, of the testes and of the ovaries. When the condition is recognized in its early stages the hopeless character of the disease renders surgical exploration advisable with removal of the tumor if possible.

The tumors originating in the medulla, called neuroblastoma or neurocytoma, are divided into two types. In one the predominant features are

metastases in the liver (Pepper) or in the skull (Hutchinson). Attention may be first drawn to the condition by ecchymosis of the eyelid rapidly followed by exophthalmos and a growth in the adjacent temporal region.

As a rule, with rare exceptions, these tumors metastasize only by virtue of the undifferentiated cells. The microscopic picture usually resembles some form of sarcoma and the absence of differentiated cells in the metastasis may result in error in the pathologic diagnosis. Roentgen ray findings of the bony metastases resemble those of periosteal sarcoma. In only a small proportion of cases is an abdominal tumor made out before death. Where the liver is involved there is enormous enlargement without ascites and, as a rule, without jaundice. There may be bilateral involvement of the adrenal. In such cases treatment is limited to radiotherapy which, in occasional instances, proves of surprising palliative effect.

In the second type the tumor in the kidney region grows to a large size without evidence of metastases, in gross appearance resembles a mixed tumor and in most instances is only differentiated by histological examination. Diagnosis of the exact origin of the tumor is usually possible only at the time of operation. In such tumors removal is indicated, followed by Roentgen therapy. If removal is impossible Roentgen therapy may be of considerable palliative effect.

## DISEASES OF THE EPIDIDYMIS AND TESTIS

The affections of the epididymis and testis which occur in childhood are similar to those met with in adult life.

**Acute Epididymitis and Orchitis.**—Acute epididymitis is very uncommon in childhood but has been described as occurring in association with acute cystitis. Acute orchitis may appear as a local manifestation in the course of any acute disease associated with bacteremia. The inflammation often resolves under conservative treatment but suppuration may occur. Orchitis as a complication of mumps is rarely met with before puberty.

**Tuberculosis of the Epididymis.**—Tuberculous disease of the epididymis is rare in childhood and usually occurs during the first seven years of life. In general the lesion is the first manifestation of tuberculosis but it may be secondary to affections of the bones or even tuberculous peritonitis.

*Clinical Features.*—While, as in the adult, the epididymis is the site of origin, the disease is frequently involved and local caseating nodules appear along the length of the spermatic cord. Invasion of the tissues of the scrotum results in abscess and sinus formation.

The course may be very acute and in a few days a considerable swelling is formed on one side of the scrotum. The epididymis and testis form a mass which is adherent to the skin, and an abscess forms and ruptures, giving

rise to a fistulous tract. In other cases the onset is gradual and symptomless and a nodular mass forms in the epididymis.

*Diagnosis.*—Tuberculosis is the only chronic disease in childhood affecting the epididymis. Syphilis and tumors involve the body of the testis. The swelling is nodular, the vas is frequently involved and there is a tendency to the formation of fistulous tracts.

*Treatment.*—Removal of the diseased tissue is indicated as soon as the diagnosis is made. Removal is restricted, if possible, to the epididymis and vas deferens. If, however, there is involvement of the body of the testis, castration is indicated. Local treatment must be supplemented by the usual general measures. When the condition is bilateral, the organ in which the disease is most advanced should be removed. If the remaining organ fails to improve, epididymectomy may be carried out, leaving the body of the testicle to supply the necessary internal secretion.

**Syphilitic Orchitis.**—Orchitis may develop in infants suffering from congenital syphilis. The affection is usually bilateral, the testis is swollen, hard and painless and a hydrocele may appear. Antisyphilitic treatment results in a disappearance of the condition.

## TUMORS OF THE TESTIS

The testis of the child may become the site of a variety of tumors, the pathogenesis and classification of which form a perplexing problem for the pathologist.

The tumor develops in the body of the testis. In the case of mixed tumors and teratomata, growth may at first be slow. This phase is followed by one of rapid growth which soon ends fatally. The sarcomata grow rapidly from the beginning and metastasize early.

**Treatment.**—Early removal of the testis and the spermatic cord followed by irradiation is indicated.

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